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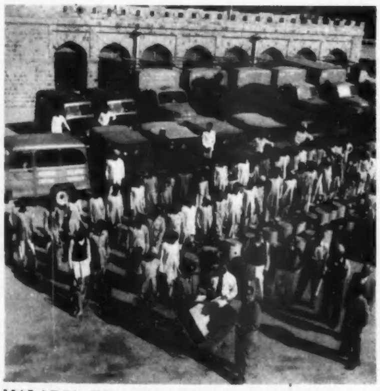


MALARIA ERADICATION—A WORLD CHALLENGE. WORLD HEALTH DAY 1960, APRIL 7.

World Health Day, observed each year on April 7, marks the anniversary of the coming into force of the Constitution of the World Health Organisation in 1948. The theme chosen for 1960 is "Malaria Eradication—a World Challenge", and the object of World Health Day is to stimulate support for the world malaria eradication campaign in all countries, whether malarious or not.

India has 390 malaria eradication units. One unit costs £32,000 to set up and comprises 4 trucks, 3 jeeps, 2 pick-ups and 247 administrative and field workers. The photograph shows part of two eradication units operating in the Delhi area.

On page 161 Mr Abba Eban discusses the whole field of science for new states.

Photo by Eric Schwab

Owing to the continued increase in production costs it been has reluctantly decided to raise the retail price of DISCOVERY *to 3s. with effect from the May issue. All current subscriptions will continue at the old rate until expiry.*

INDUSTRIALISATION: MASTER OR SLAVE?

The dynamic of 20th century society is a rapid rate of economic expansion, and with the aid of science, much has been achieved. In human affairs, however, one set of problems has a way of being succeeded by another. In the under-developed areas, the contribution of science to industrialisation and health may be nullified by the mounting pressure of population, while in the West, a more subtle process is at work: here, those very instruments essential for winning higher living standards are threatening to deprive man of their fruits, and indeed to dictate the life he shall lead. Three social abuses, the products of mechanisation, energy-consumption and locomotion, are typical but by no means exclusive, examples: noise, atmospheric pollution and traffic congestion. Why technological advance in these fields should contain the seeds of its own frustration cannot be easily answered. But the fact that in our society, science is still too frequently an instrument for achieving a specific advance rather than an all-embracing strategy for progress, is a factor we must not overlook.

Consider noise. True, the Commons have now given a second reading to a limited Noise Abatement Bill. But hitherto there has always been a naïve assumption that noise in industrial society was something to which we inevitably adapted ourselves. This complacent view has now been severely shaken. Noise, it is considered by many scientists, "is now crossing civilisation's 'threshold of pain'" and prolonged unprotected exposure to anything over 90 to 100 decibels can be dangerous. When it is realised that apart from the jet engine, which emits 100 decibels of sound at 150 ft., looms in a Lancashire weaving shed emit 95 decibels, pneumatic drills, 120 decibels, and even the averagely busy street, from 60 to 75 decibels, it is clear that the problem is not academic. Thus suppression of much noise at work, the routine as well as the exceptional, must become an increasingly important aspect of industrial policy. We in Britain are far from being a noise-conscious nation: some other countries are more advanced. In the United States, compensation paid out by industry as a whole on account of noise has risen to $40 million annually, and trade unions there are vigilant in claiming for aural damage to their members; in Italy, there is some legislation to compensate for hearing loss. But although national societies for noise-abatement have

The audiometer assesses the effect on the hearing of continual exposure to loud noise
(*By courtesy of the* Esso Magazine)

come into being in Switzerland and France, as well as Britain, and though the problem has won the attention of the European Productivity Agency, the drive is essentially a voluntary one. The problem of enforcement apart —detection can itself be a prolonged operation—extensive research is still required both into techniques and systems of measurement, suppression, and protection. While it is right, therefore, to welcome the recent establishment of a Noise Research Laboratory at Hemel Hempstead costing £20,000, we are bound to query whether in this deafening world the scale of the nation's research activity into noise is adequately financed and, more widely, whether sufficient thought to this problem is given both in the design of machinery and in conditions of work. Consultations in this field are minimal; a directing hand non-existent.

Admittedly there is a growing consciousness of the importance of clean air, but the situation with regard to atmospheric pollution is not very different. World energy-requirements are rising at over 5% annually. Hand in hand with this goes a slow but significant deterioration in the quality of fuel. There is a rising sulphur content emanating from both coal and crude petroleum. There are other factors—the specially fast rate of growth of industries emitting atmospheric pollution, the growing contribution of the motor-car population and continual urbanisation. While we should not overlook the credit side of the account —larger plants, changes in the pattern of energy-supply and not least, the vital need to recover sulphur may all limit pollution—it would be quite unrealistic to hope the problem will solve itself. Indeed informed opinion now recognises that even the modest timetable of the Clean Air Act will be unenforceable, unless industry and householders are given the tools to implement it. In particular there could be a serious bottleneck in the supply of high-grade, reasonably priced smokeless fuels. Moreover, important installations are omitted from the scope of the Act, and come under the Alkali Legislation, a sector with vast unsolved problems. Atmospheric pollution is conservatively estimated to cost this country £250 million annually, yet authority for dealing with this scourge is widely dispersed. While the Minister of Housing and Local Government is responsible for bringing into force the Clean Air Act, other independent agencies have in effect a decisive say in the feasibility of the whole operation. The National Society for Clean Air provides valuable liaison but essentially on a voluntary basis. This structure affects scientific research, which has a crucial contribution to make. The Warren Spring Laboratory, incorporating the former Fuel Research Station, does valuable research, but the Air Pollution Research Committee of the DSIR, which supervised its work, has now been dissolved. We cannot assert that the nation's striving for clean air forms part of a grand, well-thought-out design.

Finally, there is traffic (see DISCOVERY, 1958, vol. 19, No. 8, p. 311), perhaps the most notorious and intractable problem of all. So rapid is the growth of motor transport that it outstrips all provision for new road space. It must be recognised that the Road Research Laboratory's studies of traffic flow, accident-causation, and the economics of roads and road construction are slow but appropriate approaches to a scientific understanding of the problem, but their even slower application may not in itself lead to a solution. The mere spending of money to conquer traffic congestion is tantamount to pouring it into a bottomless pit. As one authority has written: "Is Motropolis, the motorised city, going to be dominated and destroyed by the motor, or is it to be a city in which civilised man lives a civilised life, using the motor vehicle sensibly and economically as a tool for mobility?" The answer involves a study of the traffic problem, not as primarily one of road engineering, but one of social planning for a progressively thought out design for living. This cannot be accomplished without an extensive research programme, embracing not merely transportation, but also location of industry, town planning and community structure. For if man does not enlist science to guide him towards the kind of transport compatible with his way of life, the force of technical improvement may itself dictate this for him and in so doing, cripple the civilisation which he seeks to build.

WORLD-WIDE WATER SURVEY BY ATOMIC ENERGY AGENCY

To learn more about the earth's water cycle, in which water from the ocean surface evaporates, forms rain and returns to earth, the International Atomic Energy Agency is going to make a study of the world-wide distribution of hydrogen and oxygen isotopes in water.

According to scientists, the ratios of stable hydrogen and oxygen isotopes in water vary for rain, river, and ocean water. In addition, very small quantities of unstable radioactive hydrogen, or tritium, are added as a result of reactions in the atmosphere brought about by cosmic rays or by the testing of thermonuclear weapons.

Much useful information can be obtained by measurements of the isotopic composition of water. For example, by comparing the tritium concentration of water flowing into and out of a lake, the average age of the lake water can be deduced. This would be of particular value in the case of underground lakes, as scientists could calculate the rate of exhaustion of these water resources. In another field, more exact knowledge of the age of deeper water masses in the ocean is very important in planning the disposal of radioactive waste material.

These measurements, however, require a great deal of technical skill and scientific knowledge. For the International Atomic Energy Agency project, samples of rain, river, and ocean water will be collected in different parts of the world and measurements carried out by a world-wide network of sampling stations and interpreted by qualified experts. Information obtained will assist countries in estimating present and future water supplies and in carrying out hydrological and climatological research. This is of vital interest to UNESCO which reports this interesting research project.

OFFICIAL U.S. SCIENCE FORECAST FOR 1970

Now that January 1, 1960 is well behind us and the crystal-gazing season has passed for another ten years, it seems a good moment to recall a document which, though it gained little attention in this country, is certainly the most remarkable of the recent season's essays in prediction. Perhaps it escaped public attention because of its snappy title: "Possible Nonmilitary Scientific Developments and their Potential Impact on Foreign Policy Problems of the United States".

The first remarkable fact about this ten-year prediction

study is that it is official. Commissioned by the Committee on Foreign Relations of the U.S. Senate, it was published in September 1959 by the U.S. Government Printing Office. The Committee handed over the actual work of predicting the world's future to the Stanford Research Institute, and Stanford passed it on to a Dr Stanley and a Mr Benveniste. These two gentlemen, helped by the staff of the Institute, wrote a hundred-page report which works stolidly through the problem of foretelling the shape of things to come with the kind of painstaking thoroughness one might expect of a textbook on magnetism. The result is a combination of good sense and sheer nonsense which is characteristic of only the very best scientific soothsaying.

The report begins by discussing the problem of prediction itself. For this purpose scientific developments may be placed on a scale. First comes the discovery of new scientific principles, then the invention of new techniques based on known principles, then the emergence of inventions from the laboratory or workshop into the everyday world, and finally the wide dissemination of the new techniques. Developments of the first kind are almost impossible to predict, but they usually take many years to influence the world. Those of the last kind are more predictable and their practical importance is immediate. All this eases the task of short-term prediction of the human condition, though it remains, nevertheless, an extremely chancy pursuit. (The authors note that a similar report in 1937 missed predicting atomic energy, antibiotics, radar, and jet propulsion.)

What new developments does the report foretell for the next decade? The list is a fantastic rag-bag of ideas—most of them reasonable, but some of them seemingly non-starters—drawn from every branch of technology. Climate and weather control, and long-range forecasting; submarines as cargo ships, as cable and pipeline layers, as bases for dredging and mining mineral deposits on the ocean floor; control of the tsetse fly; improved water supply for irrigation, by control of evaporation, by reclamation of sewage, by desalination; electrical fishing, open-sea fishing, plankton harvesting, revitalisation of barren areas of sea by stirring (for example, by atomic energy); breeding of improved plants and animals, particularly for tropical areas; biocontrol of plant disease and pests; protein from plant leaves and from micro-organisms like chlorella; chemical synthesis of foods (such as sugar); "artificial plants" (photosynthetic chemical reactors) vastly more efficient than natural plants; a cheap oral contraceptive; advances in social science leading to improved handling of the problem of economic development; political and social "inventions" offering to newly independent countries new modes of political organisation; improved harnessing of nuclear energy, perhaps by direct conversion to electricity; conceivably the harnessing of nuclear fusion energy; the harnessing of solar energy, including perhaps the adaptation of internal combustion engines to burn wood or other organic fuels; more efficient energy conversion, by means of free piston engines, of better gas turbines, of thermopiles, of fuel cells; improvement of synthetic rubber, synthetic fibres, synthetic coffee; continued replacement of natural products by synthetics in innumerable instances, from glue to diamonds; sheet-production of textiles without weaving; various improvements in the technology of radio-communications leading to more efficient use of ether space and to intercontinental television; improved information retrieval systems for stored scientific information; machine translation; cheaper international travel; international opinion polling; development of teaching machines; possibility of mind control through brainwashing or drugs; control of mental diseases.

These are the scientific developments considered possible (though not in every case likely) by the authors and expected to have an impact on United States foreign policy. Even in this formidable list there are obvious gaps. For example, there is no mention of further advance in the control of human physical disease or of the control of senility; and if a simple and cheap way were found to fix the sex of our children the consequences, for foreign policy or any other policy, would be incalculable (among other things, the world population problem might solve itself in a generation).

What have all these inventions and discoveries to do with foreign policy, and why should a government wish to indulge in such crystal-gazing? Let us take some examples at random.

Climate control. Several nations (the Soviet Union and Canada, for example) would gain by the melting of the arctic ice-cap. But if somehow this were achieved the resulting rise in sea-level would inundate London, New York, Tokyo and most of the world's great cities. The relevance of this to foreign policy is too obvious to need spelling out.

Artificial plants. Cheap chemical production of food would radically improve the prospects ahead of the underdeveloped countries. In the problem of economic advance, the hardest sector to modernise has always been agriculture. For the West, a rational estimate of the outlook for the world's underdeveloped areas is essential to the framing of a sensible foreign policy.

Synthetic coffee. It is more likely than not that a cheap and good synthetic coffee will be developed within a few years. Economic dislocation would be extreme in Brazil, Colombia, Costa Rica, El Salvador, Ethiopia, Guatemala, Haiti, and Nicaragua. For Brazil it would be disaster. A huge reduction in exports would entail corresponding import cuts. American exporters would suffer. Anti-American sentiment in Latin America would surely increase. Revolutions—probably communist—would seem likely. Has the United States any idea what it is going to do when this new product comes on the market?

From deadly serious problems of this kind the report jumps to the totally frivolous: a chart shows us, among other things, that there were 113 geographic and 4937 scientific discoveries during the 19th century. Just what this means the authors do not trouble to explain.

It is hard to imagine the Foreign Office asking Lord Hailsham to commission a report of this kind. Our diplomatic service takes itself very seriously, and there is something disreputable about forecasting the future. Nevertheless, for all the uncertainties in such a study, the false scents followed and the promising avenues ignored, the strange mixture of sense and nonsense, the sure knowledge that in ten years it will all look silly—for all this, it would do our rulers good to think in this way, from time to time, about the kind of world to expect in ten years from now. It might not change any particular policy decision, but at least it would broaden their minds.

JOHN GEORGE BARTHOLOMEW (1860–1920)

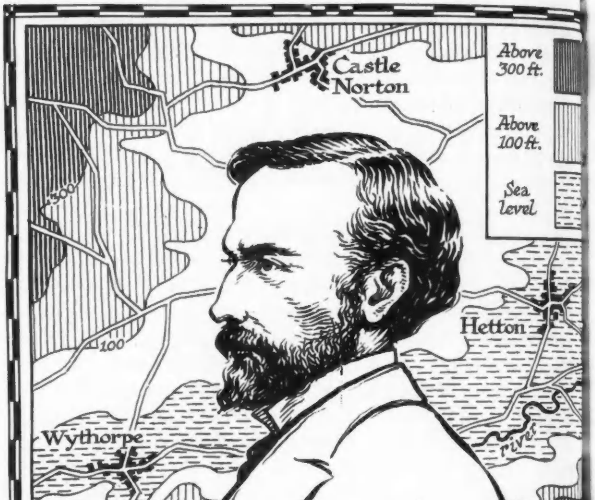
"The art of Biography is different from Geography. Geography is about maps. But Biography is about chaps", wrote E. C. Bentley in "Biography for Beginners". The division suggested by this clerihew would have been unacceptable to John George Bartholomew, the centenary of whose birth occurred on March 22, and whose outstanding achievements in the science of cartography were inspired by a love of maps and of "chaps". The loving care he bestowed on the task of making his maps living things sprang from an interest in all aspects of man's quest for knowledge, and he strove always to produce maps which truly represented man's environment.

Born in Edinburgh, he was the son of John Bartholomew (1831–93), founder of the firm of map-makers. He was not yet seventeen when he left Edinburgh University, whence he had proceeded from the High School, to enter the drawing office in the family business. He began almost immediately to experiment with the combination of contours and layer colouring which was to form his greatest single contribution to cartography. His aim was to replace hill-shading by spreading distinctive colours, tints, or shades between the successive contours in such a way that the requisite information would be available at a glance. During the 'seventies, experimental maps were submitted to the publishers, who rejected them because they were considered unfamiliar, unintelligible, and unsaleable. Bartholomew had faith and persistence, however, and the maps with "layering" executed for Baddeley's "Guide to the Lake District", 1880, were the first topographical maps of this kind to be published. In 1888 the first of the Reduced Ordnance Survey Maps featuring layer-colouring was published, quickly achieving well merited popularity, and stimulating interest in the elements of map reading and in the appreciation of well executed maps.

Bartholomew was only twenty-four years of age when he suggested the foundation of the Royal Scottish Geographical Society. With characteristic zeal he overcame various obstacles, and aided by other enthusiasts launched the Society which has won the high esteem of geographers the world over. Handicapped by ill health from early youth, he went to Australia by sailing ship when he was twenty-one to recuperate from a serious illness. Throughout his life he found it necessary to travel for reasons of health, and it was his habit to make detailed notes during these journeys. His diary of the Australian voyage was published in an Edinburgh newspaper, but he wrote comparatively little, preferring to make his contribution to geography through the map.

One of his greatest attributes was the gift of conveying through his favourite medium the facts supplied by others. Notable examples were his collaboration with the biologist and oceanographer Sir John Murray (1841–1914) in preparing the maps of the *Challenger* Expedition, and with Alexander Buchan (1829–1907), famous for the Buchan "periods", in compilation of the great "Meteorological Atlas". In these works, as in the bathymetrical surveys of the Scottish lakes, accuracy of detail was of paramount importance, and Bartholomew brought all his skill and craftsmanship to the task.

When the firm moved to new premises in Park Road, Edinburgh, in 1899, Bartholomew changed its name to the Edinburgh Geographical Institute. Among the great works issued from this establishment were the "Physical Atlas of the World", "Zoogeography", 1911, and the "Survey Gazetteer of the British Isles", 1904. The magnificent "Times Survey Atlas of the World", prepared under his direction, appeared in 1921 after his death.



Specially drawn for DISCOVERY by J. F. Horrabin.

His love of the science he served so well led Bartholomew to form friendships with fellow-workers in all parts of the world, and he was an honorary member of several foreign geographical societies. In 1905 he was awarded the Victoria Research Medal of the Royal Geographical Society "for his successful efforts to raise the standard of cartography", and in 1909 an honorary LL.D. was conferred on him by his old University. He was largely responsible for the inauguration of lectures in geography at the University, and among his bequests was a sum of £500 towards the foundation of a chair of geography.

During his last journey in search of health, Bartholomew visited Portugal, and died at Cintra on April 13, 1920. Few men can live up to a motto, but Bartholomew's devotion to his chosen work fully justified his choice of "Amore et labore".

REAR-MOUNTED JET ENGINES

The Air France Caravelle airliner was recently introduced into passenger service. This marked the practical use of a transport aeroplane with an engine configuration that two years ago was still regarded as novel. For the past two years an increasing number of aircraft concerns have come to realise that the formula for the Caravelle is the right one, and have installed the engines on their new jet transports in the same part of the aircraft.

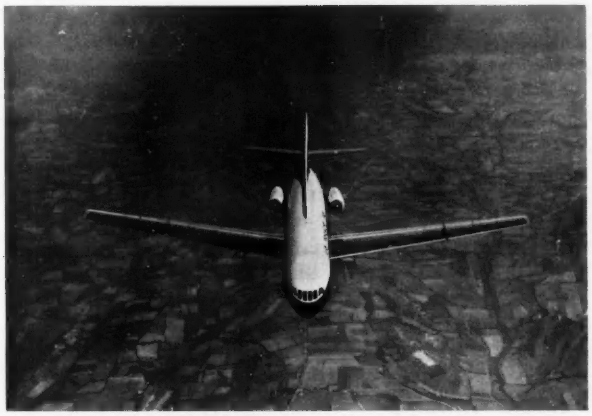
When the Sud Aviation Caravelle appeared in May 1955, it was the first airliner to have the engines mounted in pods in the rear fuselage. Many people had doubts about the success of the arrangement but these were dispelled by the aeroplane's performance, which proved extremely good. The advantages offered by the new arrangement were all borne out in practice, and other manufacturers on both sides of the Atlantic adopted rear-mounted engines. Since 1957 we have seen the emergence of no less than eight designs for rear-mounted jets and five of these are being built for civil operators.

The reasons for putting the jet engines at the back of aeroplanes are simple enough, but like all simple schemes had to be proved. In this case it was the French aircraft concern of Sud Aviation who proved that rear-mounting produced a clean wing, an extremely quiet passenger cabin, a simple method of maintenance for the engines, and a tailplane mounting free from the effects of buffeting by engine exhaust flows. When Sud Aviation demonstrated that there were no adverse effects on aeroplane performance from engines which almost followed the aeroplane through the air, and that no structural problems were presented, the way was open for imitation.

There are disadvantages with the arrangement, but they are relatively few. For one thing, the rear-mounted engine is not near the wing, which is the best place for fuel storage. Consequently the fuel runs must be taken along the fuselage length to the jets. In addition, there is the likelihood of a sizeable thrust load, in this case about 11,000 lb. being imposed on both sides of the fuselage simultaneously, or perhaps only on one side if one engine should fail. Some reinforcement of the rear fuselage is necessary to cater for the loads imposed; but in the event of engine failure which, though remote, must be considered, the asymmetric power problem presented is obviously very much less than with an arrangement where the engines are housed in pods spaced out on the aircraft's wings. On the Caravelle, fuel is pumped to the Rolls-Royce Avons from the wings, which contain the complete fuel supply.

One of the most attractive features of the rear-mounting arrangement it that the aerodynamic efficiency of the wing is at its highest because it is completely unspoiled by any engine housing. This is most important, for an immaculate wing produces a good performance and, consequently, a good operating economy. There is no doubt that the Caravelle set a fashion for engine installations which designers have wisely followed. Monsieur Satre, the designer of the Caravelle, makes no profound claim that this is the best method for all airliners, but it is worth noting that the next two British transports, the Vickers VC-10 and the de Havilland DH-121, will have rear-mounted jets, and so might the supersonic airliners of the future. Flying today are two American examples of the installation, the Lockheed Jetstar and North American Sabreliner, both small but fast utility aeroplanes.

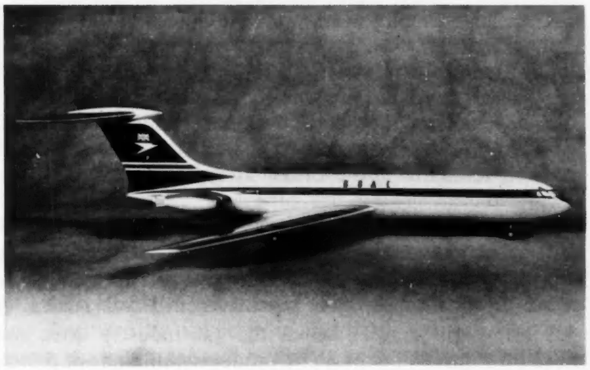
The world might have seen other examples of the method in Armstrong Whitworth's AW-167 and Bristol's 200 model, and might yet see the Hunting 107 if any operator cares for it. It is interesting to reflect now that the Caravelle, the aeroplane that started the trend, began life as a design with three engines, mounted in a cluster on the rear fuselage.



(*Above*) The design that started the trend for the rear-mounted turbojet engine—Sud Aviation's twin-engined Caravelle. Two airlines—Air France and Scandinavian Airlines—are now using Caravelles. Fifty have been sold.

(*Immediately below*) The largest and heaviest airliner planned that will have rear-mounted jets is Vickers' VC-10. BOAC has ordered thirty-five of these aeroplanes for use on the Eastern and African routes. The VC-10 will seat 152 passengers and weigh 299,000 lb.

(*Bottom*) British European Airways' short-range jet is the first to employ a three-engine arrangement, but the idea prompted by the French Caravelle remains, namely, to provide an unobstructed and "clean" wing, and a quieter passenger cabin.



WILL GAS REPLACE SOLID FUEL AND ELECTRICITY FOR DOMESTIC HEATING?

The open fires of Britain burn 35 million tons of coal a year and are responsible for much dirt, fog, and ill health. We all know this and have hitherto done nothing about it, but now the Clean Air Act compels us to look at our dearly loved open fires and to ask ourselves what we are going to burn on them. As sooner or later more and more towns create smokeless zones, householders will be required to find an alternative fuel to coal or to give up open fires; unless we are all to have new houses with something better than open fires this means burning coke and other smokeless fuels. There is at present a small surplus of coke, but increased demand would mean that the gas industry would have to build more plant, and this it is by no means willing to do.

The gas industry is a "two-fuel" industry, it makes gas and coke. Gas still holds its own for cooking and quick water heating (but only by a narrow margin over electricity), and coke is used for open fires to supplement coal, as well as for many small industrial jobs such as bread baking. At the present time the gas industry is wondering if it would do better as a "one fuel" industry making gas only. This is because the kind of coal it requires is getting scarcer and dearer and new processes offer cheaper and more flexible ways of making gas from coals hitherto unsuitable, from oil, and from refinery gases without, however, the coke which is the residue from the conventional way of gas making. There are several possibilities:

1. Coke can be turned into gas by the water-gas process. This is already done; a bed of coke is blown first with air to heat it and then with steam, resulting in a mixture of hydrogen and carbon monoxide.
2. By a rather similar process, heavy oil from petroleum can be made to react with steam to form a gas like coal-gas in composition. This also is in use to supplement normal coal gas.
3. A new pressure gasification process, the Lurgi, used in Germany since the last war and shortly to be used in Scotland, makes town gas from low-grade coal in a process like (1) using steam and oxygen. This could be used on a large scale to make gas cheaply in the coalfields and pipe it long distances; the Scottish scheme includes a pipeline from Dundee to Glasgow.
4. Oil refineries in the British Isles have surplus gas for sale.
5. A search for natural gas is going on in this country and an experimental cargo of liquefied natural gas has recently been brought here from America. There is also a possibility of bringing it by pipeline from North Africa.

Contrary to popular belief, the gas industry does not make huge profits out of its by-products. All kinds of things can be made from tar, but not at gasworks, and the industry would be willing to give up its trade in residuals and concentrate on making cheap gas were it not that it may be called on to provide increased instead of decreased quantities of domestic coke. What should the industry do, or rather, as it is a nationalised industry, what should we tell it to do? These are the alternatives before us.

1. We can give up open fires and have central heating. This is only possible on a large scale for new houses and blocks of flats.
2. We can give up open fires and heat our rooms with gas or electric fires turned on and off as we require them. This will cost us more as individual householders in fuel but ultimately all would gain by having less work making fires, less house-cleaning, and clean air.
3. We can install in our existing houses some kind of gas- or oil-fired hot-air central heating system. This is less satisfactory than full-scale central heating but is easier to install and costs less than item 2.
4. We can stick to open fires and burn coke instead of coal. Most people would say that they would want something better than present-day coke if that is to be their only fuel (or main fuel), and for easy lighting and brighter fires it undoubtedly should be improved. The gas industry can provide better quality if it has an assured market, at present it can sell just about all it can make at its present quality, so why should it worry?

In view of the large number of inhabited houses that are already fitted with open grates and the length of time most of them are going to be needed it seems inevitable that numbers of people who have not yet thought about it are going to become coke-users in the near future. To convert them from coal burning needs something more than the simple statement that coke makes a brighter fire.

Finally it must be said that there are a great many people associated with the gas industry who are confident that as soon as the new gas-making processes we have described are established throughout the country, very much cheaper gas will be available; these people believe that gas is the smokeless fuel of the future, that it will be so cheap that it will compete with electricity made in nuclear reactors, and that eventually the domestic applications of electricity will be only for lighting and for power for our vacuum cleaners, washing-machines, and gadgets. If this is the case then item 4 will be the natural alternative to burning coal on the open grate.

THE FLAT WORLD

The world is flat and rests on four wooden pillars, one at each point of the compass.

This concept of northern Alaska Eskimos was the subject of a report recently published by the Bureau of American Ethnology of the Smithsonian Institution. The report is by Dr Robert F. Spencer of the University of Minnesota, who studied the Eskimos under the auspices of the Office of Naval Research and the Arctic Institute of North America.

In Eskimo folklore, Raven (*tulugaak*) is the creator of the earth; he brought the land up from the water, made night and day, and perhaps created man. However, older cosmology, which has not been influenced by missionaries, states that the sun and moon rest on the rainbow. The moon is male, the sun female and they were once man and wife. Unfortunately, they argued about the weather: the man wanted it colder, the woman warmer. The man attacked the woman with a knife and she left and went up in the sky by the rainbow. When sun and moon shine at the same time, it is the man trying to climb to the woman.

At the time of a lunar eclipse, the Eskimos think that the moon wants dogs and travel-gear and is reaching down among men to get them. Consequently, dogs, snow-shoes, sleds, and other travel-gear are hidden.

GEOGRAPHY IS ABOUT MAPS, BIOGRAPHY IS ABOUT CHAPS

During the last half-century a school of geographers—and geography teachers—has arisen which refuses to accept the above clerihew by E. C. Bentley. They have expounded *human geography*; which is to say that, while retaining—and elaborating—the maps, they insist that geography is also "about chaps"—about the peoples of the world, their history, and their ways of life, as well as about the earth's physical characteristics. Many geography teachers have come to feel that this kind of geography should form a part, an important part, of the education of every citizen in the world of today; a world in which, if human potentialities are to be realised and, indeed, human survival ensured, all racial prejudices, barriers, and discriminations must somehow be eliminated. Men everywhere must be taught to understand, and to feel that the world today is one, and that their own lives, for weal or for woe, are inextricably bound up with happenings in other parts of the globe.

A book recently published—a combination of atlas and textbook, and, incidentally, a really superb piece of book production—will prove an invaluable aid for every teacher (and layman) who shares this view. It is "The World is Round", by Frank Debenham, with an introduction by Bertrand Russell (Macdonald, and Rathbone Books, 50*s.*)—page size, 15 in. by 12 in. Its subtitle is "The Story of Man and Maps", and it most effectively links the two. The maps are interspersed with picture pages illustrating the historical background, social customs, and contemporary economic factors of each continent (for example, Vasco da Gama's ship, Bushman cave-paintings, and the Kariba Dam, on the picture map of Africa). For the maps proper, a method of colouring is used which most successfully combines strong light-and-shade relief with "natural" colours; so that desert, grassland, or tropical forest stand out vividly against the "modelling" of the mountain regions. The global projections used, showing the world from various angles, are quite startlingly realistic. Place-names and lettering are kept down to a minimum. Looking at these maps one can go on voyages of discovery for oneself which are illuminating indeed to those of us (and that means most of us) accustomed to visualising the surface of the globe as Mercator drew it, with all the inevitable distortions and disproportions. In addition, a preliminary section of the book deals with the development of map-making, from the primitive shell-and-bamboo charts of Pacific islanders and the trail-maps of American Indians to the ordnance surveys of today; and a fine section describes the various scientific tools and methods now used in the making of maps.

In his introduction, Bertrand Russell, after stressing the urgent necessity for men to rid themselves of the old instinctive feeling—"appropriate to the Stone Age"—that all strangers are enemies, goes on to say, "We have to learn that the world is round, and that it does not have its centre where we happen to live. *This is a lesson that geography can teach.* But there is a further lesson, to be learnt from Astronomy: the Earth, which once seemed large, is no more than a tiny speck of dust in a Universe of unimaginable vastness." This book most effectively teaches these lessons.

MAN'S EVOLUTIONARY ADVANCE

Dire predictions that mankind is on the way downhill—perhaps even on the road to extinction—probably are unjustified.

This is stressed by Dr Theodosius Dobzhansky, eminent Columbia University zoologist, and Dr Gordon Allen, of the New York Psychiatric Institute, in a report recently published by the Smithsonian Institution.

Pessimistic prophecies have been frequent in late years, some by distinguished geneticists. They are based generally on the claim that facilities of modern living and especially medical advances are keeping alive the less fit and enabling them to produce families. This may continue at an ever increasing rate for millennia, with each generation becoming somewhat less fit than its parents.

This is currently a matter of frequent discussion, with the observance last year all over the world of the centennial of the theories of evolution put forth by Charles Darwin. The core of the Darwinian thesis is the survival of the fittest—the fittest, that is, within the requirements of the environment of the species.

Here, says the report, comes the rub. Man undoubtedly is losing some of the qualities, both physical and mental, which served him well in the environment in which the ancestors of the human species lived. There are, of course, individual exceptions. The race as a whole, hasn't the physical strength it had in the days of the cave-men when it was necessary to fight savage beasts armed only with clubs, or even with the bare fists.

The great error, according to the two geneticists, lies in assessing the value of hereditary characteristics without taking the environment into full consideration. No species lives in a vacuum.

Now, the report stresses, the present environment of man, which did not exist in Nature and which he himself has created, is unique in the world. It demands a different kind of man to survive and progress. Perhaps some of the characters reputedly being lost actually might be handicaps in the civilisation of the future. The cave-man, for all his strength and primitive resourcefulness, would not get along too well in a modern city.

Drs Dobzhansky and Allen admit that there probably are disruptive forces at work in human heredity. At present it is impossible to assess their significance.

"The idea explicit in many writings," they conclude, "that all would be well with the human species if all obstructions to natural selection were removed does not stand critical examination. The genotypes which possess the highest Darwinian fitness in the environment created by man's inventive genius are not the ones which were most favoured by selection in the past. Natural selection cannot maintain the adaptiveness of human populations to environments which no longer exist, nor can it pre-adapt them to environments of the future.

"Man has reached a solitary pinnacle of evolutionary success by having evolved a novel method of adapting to the environment, that by means of culture. Having ventured on this biological experiment, our species can no longer rely entirely on forces of natural selection as they operate on a biological level. He must carefully survey the course that lies ahead and constantly study his genetic progress. Only thus can he ensure himself constant evolutionary advance."

SCIENCE ON THE OVERSEAS BBC

For a clear and continuous picture of what is happening in British science, listen regularly to the External Services of the BBC. The thoroughness with which scientific achievement is presented and the extent of coverage are astonishing. Not only is every major happening and development in applied science and technology reported, but also a serious attempt is made to give some idea of the fundamental nature of pure science.

The External Services are "heard throughout the world (in English and forty-one other languages) for over eighty-one hours every day. This is larger than the output of all the domestic sound and television services added together . . . ," reports the *BBC Handbook, 1959*. The programmes are financed by a Grant-in-Aid voted annually by Parliament: they project Britain. The broadcast output is primarily on short waves, although medium and long waves are used for parts of Europe and during darkness when the home services are closed and when these wavelengths carry farther than in daylight.

Of the total programme time available in the European English Service, at least one-fifth is given to science and industry. The European Services are pioneers in the presentation of science in that they were the first of the BBC Services to appoint a full-time science correspondent—and that as long ago as 1947. One of the leading programmes is entitled "Enterprise". It is a fortnightly feature which covers a wide range of British achievement. A "Frontiers of Knowledge" series has carried talks by scientists themselves on subjects ranging from Stonehenge to New Tissues for the Lethally Irradiated.

The BBC North American Service produces programmes for rebroadcasting by American and Canadian stations and networks. This means that NAS programmes must be tailored to fit in with the North American pattern of broadcasting. The Service gives extensive coverage to scientific subjects—for example, NBC network's (196 stations) popular week-end programme, "Monitor", has had three talks by Prof. Lovell on Jodrell Bank.

Scientific subjects are also covered occasionally in "Byline" and "Commentaire", two weekly commentary series for Canada which are normally devoted to political and international affairs. Programmes in these series were recently devoted to the British Space Research Programme and to British Design of Atomic Power Stations.

In addition, scientific subjects are frequently covered by NAS in its regular magazine programmes, "Dateline London" (carried weekly by almost 150 American stations in forty-nine States), "International Almanac" which is heard monthly on thirty-seven U.S. stations, and the weekly news magazine programme, "Call from London", which is broadcast by some sixty-five stations in the U.S.A.

A regular programme is the weekly "Science and Industry", whose precept, as stated by its scientific advisor in its first edition, is: "The sense of science as an adventure, in which man enters imaginatively. The techniques of our age are impressive, the inventions are prodigious, but the real gift of our age goes deeper than these. The gift of our age is that it is making science a natural part of man's culture."

The Far Eastern Service merits special mention because it initiates so many worth-while projects. For example, Sir Christopher Hinton gave a series of talks on "The ABC of Atomic Energy" in English, at the original invitation of "London Calling Asia", which have been transmitted all over the world. They are also available as a BBC publication of which over 52,000 copies have been sold. Another book shortly to be published, entitled "The Searching Mind", is based on a series of half-hour programmes in which leading scientists spoke about their frontiers of research. The broadcasts in this Service are in eight native languages and in English. There is also extensive re-broadcasting of these transmissions. Typical programmes are as follows: Chinese, "Science and Industry", weekly; Indonesian, "Science Review", monthly; Japanese, "Science Survey", weekly; Malay, "Science and Industrial Magazine", weekly; Thai, special talks; Vietnamese, special talks; Urdu (for Pakistan), special features and "Question and Answer" science; Bengali (for Pakistan), special talks; Hindi (for India), "Science Survey"; Persian, "Science Notebook"; and for English-speaking Asians there is the "World of Science", weekly; "Inside Information" (in which the science behind the news is made clear), and "New Ideas" (industrial development). For Africa, there are vernacular science programmes in Somali, Swahili, and Hausa, and a regular fortnightly programme, "Science Survey".

The Eastern Service is the largest of the regional services in foreign languages. There are nine different languages used, of which the principal is Arabic.

If the ordinary British citizen could listen regularly to the science programmes put out on the External Services his knowledge of the scientific revolution that is transforming his life would be very much greater.

Eggs of Common Winter Moth on oak twig. Greatly enlarged.

MOTHS IN WINTER

A large majority of the more than 2000 species of moths inhabiting Britain are on the wing from April to September, but a limited number appear only during the autumn and winter. These more hardy members of the race are loosely termed winter moths, but there are only two species to which the title is applied correctly. They are the common winter moth (*Operophtera brumata* Linn.) and the pale winter moth (*O. fagata* Scharf). In both species the females are wingless, but the males are amply equipped for flying. The male common winter moth has grey-brown fore-wings, but those of its relation are paler and slightly larger. These moths fly in the evening, and can be found resting on tree trunks and fences by day. They are classed as pests because their caterpillars attack the opening foliage of various trees, including those growing in orchards, in the spring and early summer. Gardeners and foresters use sticky bands to trap female winter moths and their allies as they ascend the trees to lay eggs.

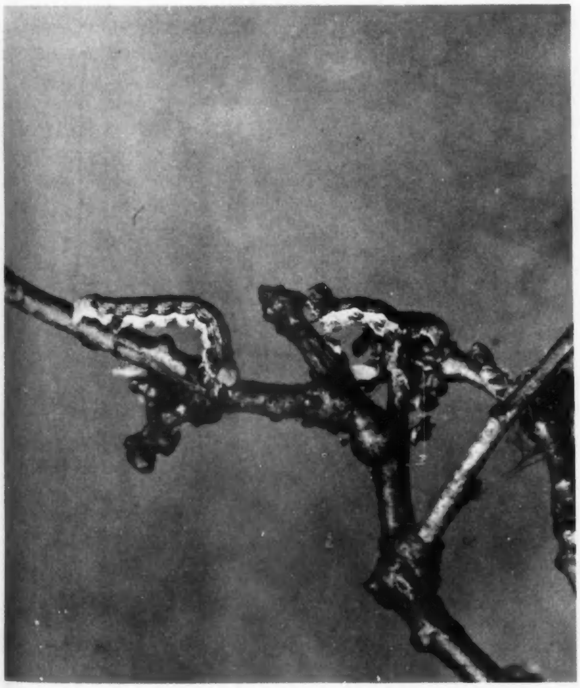
The more colourful mottled umber moth is another species in which the female is apterous, and it can be found from November until January. The males vary considerably in markings, some having wings of pale ochreous brown with faint cross-lines, others being chestnut-coloured with very dark bands. The closely related scarce umber moth can be identified by its orange wings, but again the female is minus wings. The caterpillars of both species are often common in woods, and in some years they strip all the leaves from the oaks and birches during early summer. It is for good reasons that the mottled umber is called *Erannis defoliaria*.

The greyish November moth can be seen in October, but late examples linger until Christmas. Both the sexes have wings, and the species is common in many wooded areas. The male and the female December moth are also winged, but they belong to a different family of moths and are allied to the lackeys and eggars which appear in the summer. Their caterpillars are greyish, with a slight covering of hairs, and they are easily distinguished from the "Looper" caterpillars of the winter moths and umber moths.

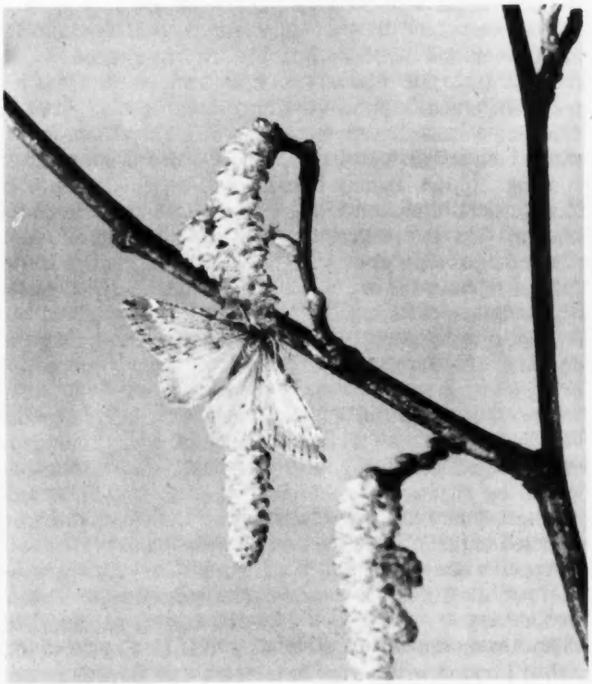
The appropriately named early moth appears at the end of January, and it has a preference for well-grown hawthorns in woods and hedgerows. The brownish males flutter around after sundown in search of the wingless females resting on the naked twigs. The more attractive spring usher moths begin to emerge in February, and the winged males vary from pale brown and grey, with cross markings, to a deep uniform sooty shade. The apterous females could be mistaken for small spiders as they hide in crevices of bark and amongst dead leaves.

Also in February appears the more impressive pale brindled beauty, a woodland species which rests by day on the trees. The wings of the male have a span of about two inches, and they vary in colour from pale olive green-brown, speckled with grey, to sooty black. The darker, or melanic, examples are more numerous near towns and in industrial areas affected by smoke. The wingless females also rest on bark, and the dark-brown caterpillars eat the leaves of many woodland trees in the summer. The dainty March moth hides amongst dead leaves, or in bark, by day, and the male emerges in the evening and searches for the apterous female. He also occasionally visits the long catkins of the hazels for refreshment. Other moths that appear only in the autumn and winter include the dotted border and the small brindled beauty. Their habits are similar to those of the species described here.

Caterpillars of the Mottled Umber Moth on oak.



A male March Moth on hazel catkins.
(All photographs by George E. Hyde, F.R.E.S.)



FOOD FOR SURVIVAL

The preservation of fresh food by canning was developed to meet the needs of forces in combat, men at sea, and exploratory expeditions. Modern methods have provided a lighter and more compact survival ration.

PART ONE: HISTORIC

B. J. B. POLLARD

The British Food Manufacturing Industries Research Association, Leatherhead, Surrey

It would be no exaggeration to say that if a really efficient method of food preservation had been discovered centuries ago, the course of history might well have been changed and the growth of knowledge of the world in which we live could have been accelerated. The wars that were lost and the expeditions that failed through the debilitating effects of poor-quality foods were innumerable. An example of the dreadful effects of debility can be seen from the voyage of Admiral Anson to Juan Fernandez in the 18th century. Of the 961 men who went on this expedition, only 335 survived the voyage. In 1780 the English Channel Fleet was withdrawn from service during a war with France because of scurvy outbreaks amongst the crews (caused by a diet lacking in Vitamin C).

The discovery of the art of canning fresh foods came about through the French Government's concern for the welfare of its widely deployed forces. This was during the years after 1789, when France was in the midst of a revolution at home and was waging wars abroad. The problem of providing the French forces with satisfying and well-balanced food became really serious. Therefore, in 1795 the French Government offered a prize of 12,000 francs to anyone who could produce a practical method of preserving foodstuffs for long periods. They could see the dire need for survival foods.

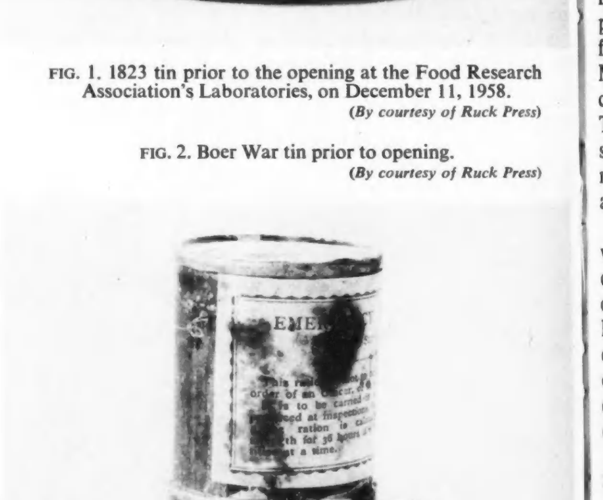
However, the prize was not claimed until January 30, 1810, when one Nicolas Appert, a Parisian confectioner in the Rue des Lombards, came forward with a sound idea for preserving food. Appert was born at Chalons (Marne) in 1750 and educated in the home of the Duc des Deux-Ponts, where between the years 1772 and 1775 he learnt the art of cooking. Appert, signing himself as "Ancien Confiseur et Distillateur", discovered that if he placed food in wide-mouthed jars, sealed them hermetically with layers of cork and wax, and then placed them in boiling water for various periods of time, the contents "retained their original freshness". Although bacteriology was in those days unknown, Appert saw the need for heat sterilisation after sealing the contents. His stout glass bottles were securely stoppered before heating.

"Le Citoyen Appert" preparations were tried out by the French Navy in 1806. They consisted of a wide range of meats, vegetables, fruits, and even milk. It was acknowledged by the naval authorities of Brest that the meats were good and that the vegetables were equal to those gathered in their seasons.

Appert's classic treatise, "Le Livre de Tous les Menages ou l'Art de Conserver pendant Plusieurs Années Toutes les Substances Animales et Végétables", was published in 1810. Almost immediately following this, one Peter Durand visited London with a view to taking out an English patent

FIG. 1. 1823 tin prior to the opening at the Food Research Association's Laboratories, on December 11, 1958.
(By courtesy of Ruck Press)

FIG. 2. Boer War tin prior to opening.
(By courtesy of Ruck Press)



for the new process of food preservation which specified the use of tin plate for the container. In the same year a man named Donkin from Northumberland, a born inventor, had the vision to purchase "all the patent rights" from Durand for £1000. By 1811, we learn Donkin and his associates, Hall and Gamble, had made a profit of £2212, having successfully processed foodstuffs in tinned iron containers.

SOUP AND BOUILLI

The word *can* is short for *canister*, and is derived from the Greek *kanastron*, a basket made of reeds which was used for carrying foods. The early tinplate containers or canisters were heavy affairs by modern standards, a hammer and chisel being recommended for opening in the instructions marked on the label. John Hall financed Donkin, and the whole venture became a partnership. The business developed rapidly and agents and stocks of preserved foods were established in many seaport towns in Britain.

From the outset, canned foods were a success in the Navy, and in 1814 we hear of Admiral Cochrane, commanding the West Indies station, ordering Donkin's "patent preserved meats" as a diet for sick sailors. This preserved meat, known as soup and bouilli, is reputed to be the origin of the term "bully beef".

Canned preserved foods were used extensively on the great exploratory voyages, notably those of Parry when seeking a North-West Passage. In 1820 the surgeon on the first Parry expedition wrote from HMS *Hecla* that the preserved foods supplied by Donkin were an important factor in maintaining the expedition's high health standards. Medical testimonies were frequent, and in spite of the high cost of these foods the armed forces bought large stocks. The reason for the high price (roasted beef, 2*s*. a medium-sized can) was due mainly to the laborious can-making methods. One tinsmith produced ten per working day, as against a modern line turning out over 800 per minute.

The manufacturer's outlets for canned foods during the very early days of the industry were the armed forces and exploratory expeditions. It has been established without doubt that as survival rations for sledge-parties and suchlike they had no equal. In fact, since the very early days of commercial canning this type of package has been used on explorations, expeditions, and campaigns as standard equipment and has now given satisfaction in extremes of climate for 150 years.

The first canned foods reached British shops in 1830. Sales were initially slow due to price—a can of green peas at 3*s*. a quart was approximately the cost of a week's rent for an average-sized house. However, Donkin and his associates did well and there is a record of his selling £3000 worth of preserved meat alone in six months. In 1836 Donkin was made a Fellow of the Royal Society.

THE AMERICAN FRONTIER

The industry in America was born in 1819 when an Englishman, William Underwood, started a factory in Boston. Wide-mouthed glass jars and cork stoppers were used in a process similar to Appert's. Also at that time one Thomas Kensett set up a New York factory, using the same technique. Underwood was preserving such items as pickles, sauces, and Kensett, salmon. By 1839 both Kensett and Underwood had started using metal containers instead of bottles, and it is believed that they owed their knowledge to Durand, who by then had left England and gone to the New World. All cans at this time were made from sheets of tinned wrought-iron and not steel, which is, of course, now the basis of tinplate.

Kensett and Underwood found excellent markets for their preserved foods, mainly because of the progressive expansion of the American population westwards. People relied on canned food during their westward trek. The famous wagon trains, proceeding towards the fertile lands of the West, had to cross deserts and wastelands. Canned food, therefore, became, literally, the American civilian's food for survival during these perilous journeys. In this way canned preserved foods became a part of the American domestic way of life.

The first milk-canning factory came into being in the New World in 1856. Finally, the American Civil War caused an upsurge in the demand for food preserved in this way. The Chicago meat-canning industry was founded in 1872, and so by now the American canning industry was in full swing.

Speed in producing these new preserved foods became vital in all countries using the process. Here again it was in Britain that the first pressure-cooking of the food to be preserved was invented. This was in 1837, when a Mr W. Hogarth used high-pressure steam (a version of our modern pressure cookers). This method cut down the time taken to cook the food and so speeded the process. However, in 1874 a Mr Scriver of Baltimore, U.S.A., brought out the pressure retort, and the Americans applied this process on a large scale. Next came an altogether new type of canister—the open-top can—to speed production. The old can had a hole in the top, through which the food was passed, before sealing on a small cap by means of hand soldering. This meant the chopping up of the foodstuffs into small pieces.

The open-top can, which enabled larger amounts of food to be placed in the canister, came into being in 1904. This type of container was in two parts, and the food manufacturer usually hired the necessary machinery from the can supplier in order to seal the two parts together on his own premises.

Recently, in the Leatherhead, Surrey, laboratories of the British Food Manufacturing Industries Research Association, the contents of several historic food packs were investigated. One of these dated back to the very early days of commercial canning. This canister, opened in December 1958, was dated 1823. It was supplied by Donkin, Hall, and Gamble for Parry's voyage in search of a North-West Passage in early 1824. When opened at the Food Research Association laboratories it was found to contain roast veal. The meat fibres were edible, although the fat had emulsified and was rancid. No living bacteria were found.

Also in 1958, in conjunction with scientists from the Ministry of Agriculture, Fisheries, and Food, the Research Association opened up various containers from the Shackleton and Scott expeditions of 1908 and 1910. One of these samples was notable in that it compared very favourably with the modern control sample and had, in fact, improved on storage.

Such findings have yielded much valuable information to those scientists specially concerned with food storage problems, for it assists manufacturers to prepare even better foods for survival and otherwise, both now and in the future.

PART TWO: PRESENT AND FUTURE TRENDS

J. W. SELBY

British Food Manufacturing Industries Research Association, Leatherhead, Surrey

During its development into the vast industry of today, canning has undergone no fundamental change in principle since Donkin and Hall commenced their operations almost 150 years ago. However, from being a somewhat hit-or-miss and rather tedious process it has become a mechanised, high-speed industry, which is scientifically controlled within precise limits at all its critical stages. It is now known that, in fact, the heat treatments given in the pioneer days were frequently inadequate to sterilise the cans.

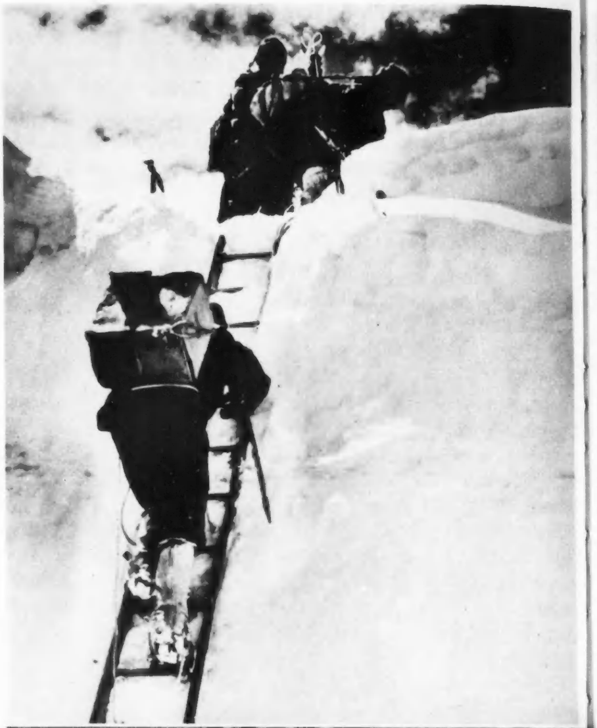
In strong contrast to the 1823 hand-soldered can made from heavily tinned wrought-iron, cans are now made from a light-gauge tinplate which, in the latest method of manufacture, is produced by electroplating a very thin layer of tin on both sides of a continuously moving steel strip. Cylindrical cans, which form the bulk of those used, are fabricated on lines operating at speeds of about 800 per minute. Soldering is used only for the side-seam, the bottom being attached by the now familiar rolled "double-seam" which is sealed by a thin film of rubber compressed between the layers of tinplate. The top is attached to the filled can at the cannery in the same manner, frequently with simultaneous application of a vacuum so that as much air as possible is withdrawn from the can at the moment of closure. This helps to preserve the colour and flavour of the food and to reduce corrosion or chemical interaction between the can and its contents. Further protection from corrosion is obtained where necessary by coating the tinplate with inert lacquers based frequently on phenol-formaldehyde or epoxy resins.

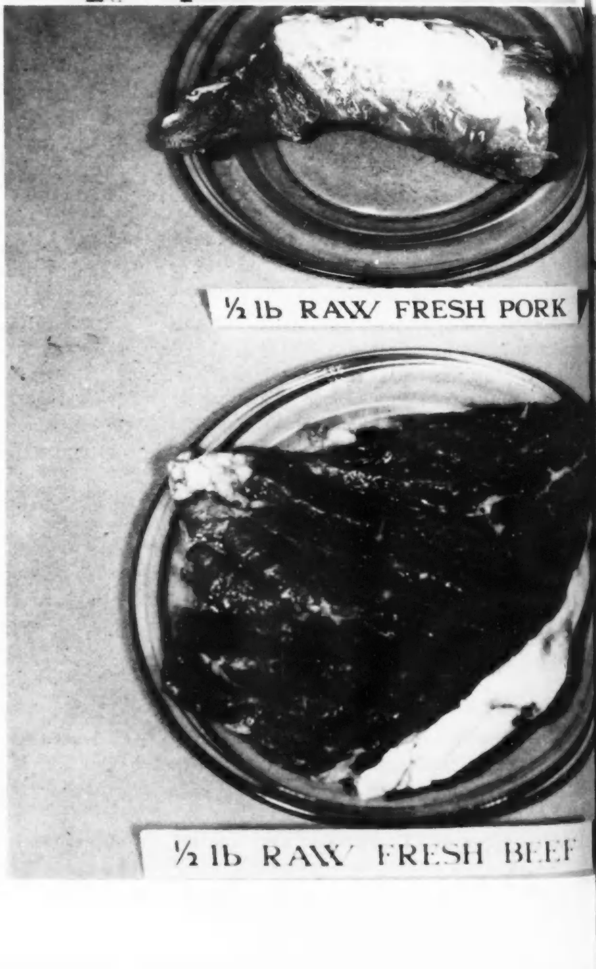
The filled cans are sterilised under pressure in steam-filled autoclaves holding many hundreds of cans at one loading. The temperature and duration of this heating process are calculated from the previously measured rate of heat penetration into the centre of typical cans of the food being packed, and are arranged to be such as would kill *Clostridium botulinum*, which is the cause of the type of food poisoning known as "botulism" and is one of the most heat-resistant organisms known. Thus are the safety and reliability of modern canned foods ensured.

These developments, together with the latest methods of preparing foods for canning, as well as the careful selection of specially grown varieties of fruits and vegetables, have resulted in an enormous range of canned foods of excellent quality and nutritive value being made available to the armed services and to the various expeditions of recent years, as well as to the world at large.

NEW DRYING AND PACKING METHODS

In connexion with the victualling of the Trans-Antarctic Expedition of Sir Vivian Fuchs, the subject of polar sledging rations was given much attention by the Medical



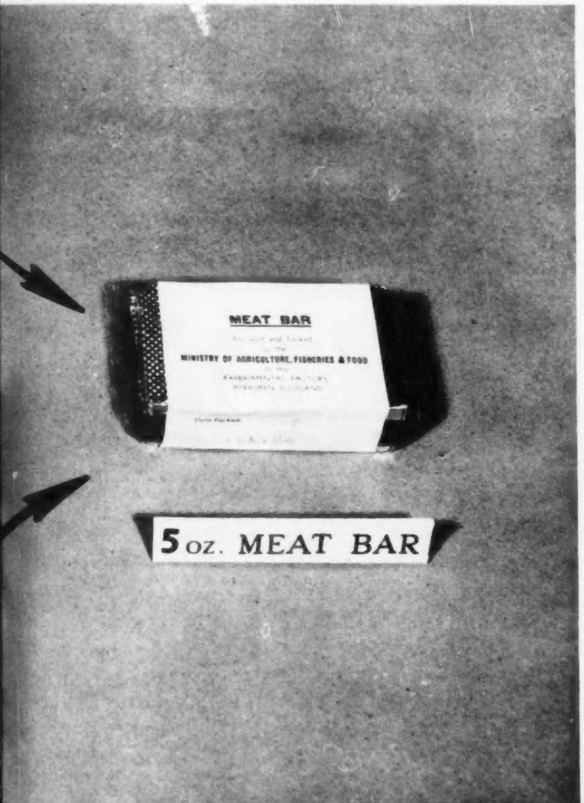


Research Council. The sledging ration is the food carried by men whilst sledging, and must be distinguished from the food, mostly canned, which is deposited for use at the base camps. The former is vitally important, since it must be capable of supplying energy and boosting morale during long periods of very hard physical work, without being unduly heavy and bulky. Studies made during the British North Greenland Expedition, 1952–4, had led to the conclusion that a ration supplying 4800 calories per man per day was necessary to maintain the balance between food intake and energy expenditure, whereas the standard type of rations used by polar expeditions since 1930 supplied only 4200 calories.[1] It was therefore decided to design a new type of ration, several experimental prototypes of which were produced and tested with considerable success. This work is still going on and ultimately it is hoped to evolve a new standard polar sledging ration.

The most important constituent of the new type of ration is a dehydrated meat bar, consisting of approximately 60% fat and 40% dehydrated minced beef. It has the same calorific value as the pemmican which it replaces and, in contrast to it, is very palatable whether eaten dry or reconstituted into a minced beef stew. The total calorific value has been stepped up to the new level and some variety has been introduced by additions such as cheese, dried soups, coffee-powder, tea-powder, sweets, and condiments; all this being accomplished without unduly increasing the overall weight.

FIG. 3 (*left*). Every ounce counts. Supplies being carried up an ice wall. Kanchenjunga Expedition 1955.

FIG. 4 (*below*). Picture illustrating the saving in weight achieved in the meat bar.



Two things have contributed to this development. The first is the availability of light-weight plastic film and aluminium foil wraps. The rations are now packed in small units in disposable containers instead of being carried in bulk in the older heavy containers. The second is the great progress which has been made in food dehydration, particularly in this country by the Ministry of Agriculture, Fisheries, and Food, which produces the meat bar at its experimental factory in Aberdeen.

Dehydration is one of the oldest methods of preserving food and was practised by the ancients, but although it has developed on a commercial scale for certain specific foods such as dried egg, dried milk, and some vegetables, it has not hitherto found the same wide application as canning. This is mainly because most foods when dehydrated by the conventional processes which involve application of heat to drive out the moisture, undergo noticeable deterioration. The ideal dehydration process will yield a product which, when reconstituted by the addition of water, is indistinguishable from the fresh food. The older methods for the most part fall far short of this ideal. The method developed by the Ministry, which is known as freeze-drying, comes closer to the ideal than any other. It produces excellent results, particularly with foods such as meat, fruit or vegetables which possess definite structure. The principle is a very simple one, and is not new. It depends on the fact that at temperatures below 32°F and pressures below 4·7 mm. of mercury, ice will vaporise without the intermediate formation of liquid water. The great advance lies in the Ministry's development of the process to a commercial scale.[2] The procedure briefly is to freeze the food, place it in a vacuum chamber and supply sufficient heat to cause the ice crystals to vaporise without melting. In this way, if the food is meat, the fibres do not become wetted during the drying process and the meat retains a rigid open structure, which will reconstitute very readily, restoring the original texture when water is again added. Since at no time during the process does the temperature rise much above freezing-point and since oxygen is excluded by virtue of the vacuum in the system, there is a minimum of chemical deterioration and the flavour and colour remain unaltered.

Foods dehydrated in this way will keep almost indefinitely, provided they remain completely protected from moisture and oxygen. Furthermore, their extreme lightness and the ease with which they can be reconstituted make them very attractive as food for the armed services. A considerable amount of development work has already been done by the War Office in collaboration with the Ministry, as a result of which various new types of ration-packs are under trial, including a combat ration for one man for twenty-four hours which incorporates the meat bar already mentioned and a new light-weight composite ration for five men. The comparison between this and the existing standard composite ration is well illustrated in the photograph.

As already mentioned, a very efficient protective wrapper

FIG. 5. Picture illustrating the comparison between the Standard-man Army Composite Ration and an experimental Lightweight Ration made up from dehydrated foods.

(Crown Copyright)

is necessary to ensure satisfactory preservation of these foods under all the climatic conditions likely to be encountered and a considerable amount of experimentation with several types of film and foil package has been carried out. It is by no means certain that the final solution of this part of the problem has been found, but the best results so far seem to have been obtained by the use of a heat-sealable triple laminate of Melinex, with aluminium foil and polythene.

Similar types of experiments are also going on in other countries, including the United States, and it is interesting to speculate on the probable future development of freeze-drying from the point of view of the ordinary housewife. As in the early days of canning, the high cost is likely to keep these foods off the domestic market for a time, but there seems to be little doubt that this difficulty will be overcome and that freeze-dehydration may then have as big a future before it as had canning in the early 19th century.

EMERGENCY SURVIVAL RATIONS

So far, no reference has been made to survival rations in the literal sense of rations carried to enable a man to remain alive under adverse conditions, as, for example, until rescued after baling out from an aircraft over the ocean. This problem has been studied by various workers but especially by Hutchinson, who reaches some interesting conclusions in a recent book.[3]

A man cannot continue to live for long without water, although he may survive for a considerable period without food. If he is fortunate enough to land in a place where fresh water is to be found, then the probability is that he will be able to find a certain amount of food as well to enable him to survive for a considerable period. However, in the event of his being lost at sea or in the desert the question of water conservation becomes a very important one. In such circumstances, food must be of such a nature as not to promote excessive excretion of water. Foods containing appreciable amounts of protein would be undesirable in this respect since they would tend to break down to urea, which would be excreted by the kidneys.

Hutchinson concludes that for a restricted ration of 500 calories per day to cover a period of six days, the best that could be provided would be 4½ oz. of glucose tablets plus 1 pint of water per day. The survivor on this diet would need to reduce sweating as much as possible by sheltering himself from the sun and to avoid physical activity, and on no account should he drink sea-water, since the salt which it contains causes dehydration of the tissues. Seasickness pills should be provided to prevent vomiting.

Since a survival ration in an aircraft is strictly limited in size and weight, these usually contain either small inflatable solar stills or ion-exchange water-purification outfits to enable drinking-water to be obtained from sea-water.

Finally, some mention must be made of the various

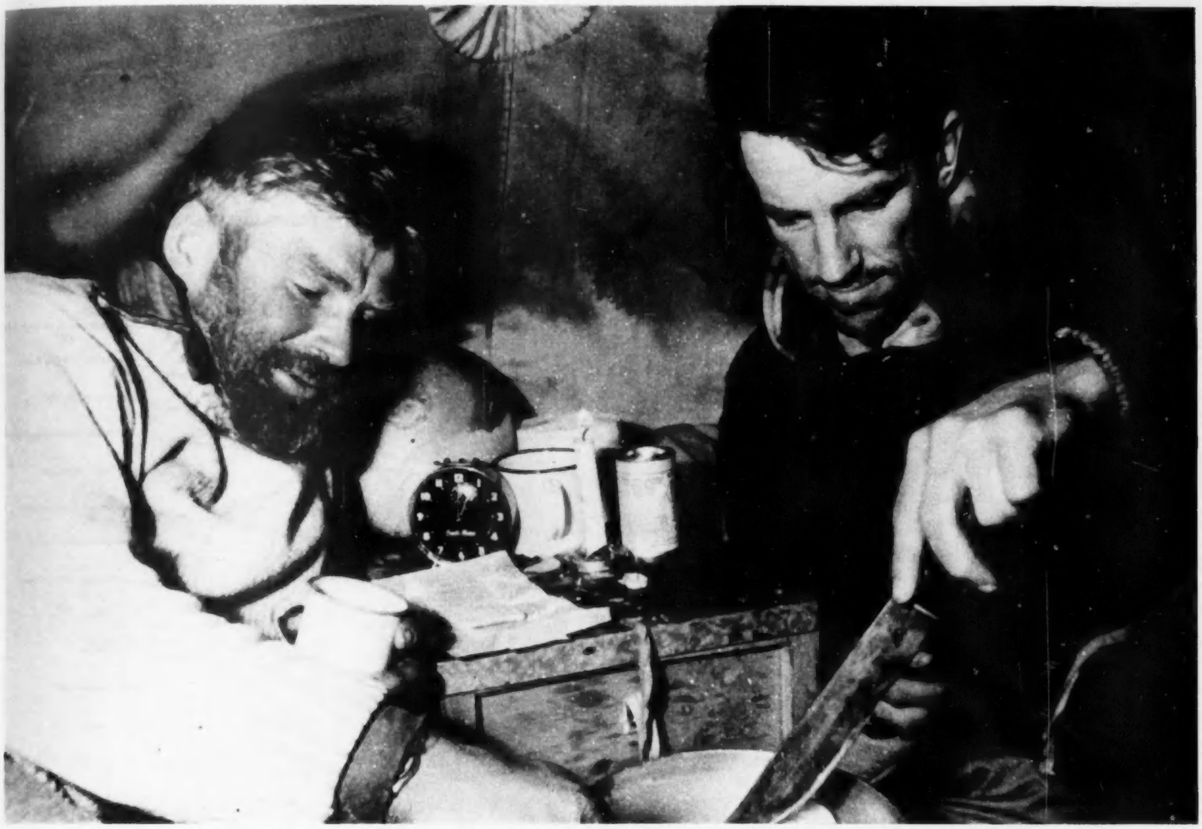


FIG. 6. Sir Vivian Fuchs and Sir Edmund Hillary prepare a meal. Commonwealth Trans-Antarctic Expedition.
(Crown Copyright)

proposals that have been put forward for the feeding of adventurers in outer space. Russia is known to be working hard on this problem, and in the U.S.A. a whole session of the 1958 Annual Meeting of the Institute of Food Technologists[4] was devoted to this topic.

The problem of a short trip to the Moon, it seems, is a relatively simple one, since it would be possible to take dehydrated foods in sufficient quantity to cover one man's requirements for a week or two. It would still be necessary to arrange for the water lost by perspiration and excretion to be recovered, purified, and re-used, since the extremely small payload would not permit of carrying the full amount of water required. Nauseating as this may seem, it is only an example on the small scale of the natural processes which go on around us.

On a really long interplanetary voyage, lasting several years, such as a return visit to Mars or Venus, the would-be space traveller would have to be virtually self-sufficient in his small artificial planet. This would entail the establishment of a closed biological cycle, by means of which his bodily wastes could be continuously reconverted into foods.

Most of the proposals for such a system envisage the cultivation of algae in tanks. They would utilise the carbon dioxide in the atmosphere with the aid of light-energy from the Sun and would replenish the supply of oxygen. They would also provide almost all the carbohydrate, fat, and protein requirements necessary to sustain a man. In addition, the water-purification cycle would have to be maintained, as already suggested. Some form of vitamin supplement would also have to be carried.

Simple as such an arrangement seems on paper, it is beset by very great difficulties. Probably the least of these is the problem of weightlessness caused by the absence of gravitational forces, which would make eating off a plate or dinking out of a cup an extremely hazardous, if not an impossible procedure. To overcome this, it is suggested that the food should be sucked from flexible tubes.

It is not yet known whether a human being could assimilate such a diet, let alone exist for long periods on it. Even supposing it were nutritionally satisfactory, it is unlikely that a man could stand the monotony for long. With this in mind, some workers have suggested that an animal of some kind should be introduced into the cycle to give variety in the form of a supply of fresh meat. Room might even be found for an occasional souvenir of earth-bound days such as a dehydrated meat bar. However, if one thing is certain above all others, it can only be that it is merely a question of time before these nutritional problems are solved and man's conquest of outer space may then become an accomplished fact.

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DWARFING THE PERILS OF THE SEA

PAUL WIGMORE

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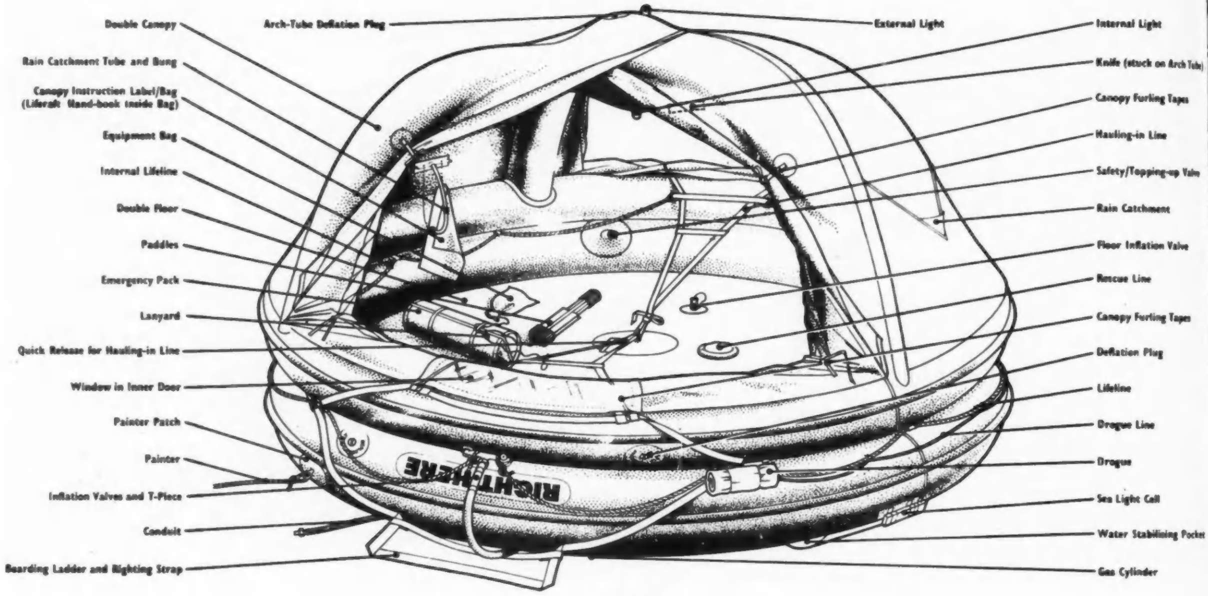
Inflatable liferafts are fast replacing lifeboats and may put an end to loss of life at sea. More quickly manned, they are also more stable in rough water, and provide protection from the elements.



M.M. MK. 2.

Sea and air travellers are becoming used to the word *liferaft*. Phrases such as "26-man liferaft stowed here" are stencilled in unlikely places above their heads as they fly; white barrel-shaped containers on board ship announce in black letters that they contain "Liferaft for 20 persons". Trawlermen know them well; they have had them on board as compulsory equipment since 1956. During the last war 17,000 British and Allied airmen were saved by them. Liferafts are dwarfing the perils of the sea.

Fig. 1 shows a sketch of a typical liferaft. It consists of two independent circular rubber-proofed fabric buoyancy chambers, one on top of the other. An inflatable column (or arch tubes connected to the upper chamber) supports a double-skinned canopy, and this canopy completely protects the occupants when it is closed. The floor, too, is double-skinned and is inflated by hand after boarding. Thus an insulating cushion of still air completely surrounds the survivors and protects them from extremes of cold and heat. A hand-launched drogue and water-pockets under the liferaft help to reduce drift and to keep the liferaft stable.

Shipboard liferafts are stowed on deck in a canvas valise or a rigid canister. Launching is a simple matter, for most are just picked up and thrown overboard, no unpacking being necessary. A painter, previously made fast to the ship's rail or other firm point, connects the floating valise to the ship. A sharp pull on this line operates a gas cylinder inside the valise and within less than a minute the liferaft has burst out of its container and is lying alongside ready to be jumped on from the deck or climbed into from the water.*

Inflatable liferafts are stowed in the wing and fuselage on board troop-carrying and Service aircraft and airliners almost universally. Upon the operation of a lever inside the aircraft the wing-stowed liferaft blows off a small wing panel, inflates on the wing of the floating aircraft and can be slid on to the water ready for boarding by the passengers. The fuselage-stowed liferafts are operated in much the same way as the ship's liferaft.

THE PAST

Since about 1840, when the British rubber pioneer Thomas Hancock was causing world-wide interest in the apparently unending uses of caoutchouc, inflatable rubber life-saving equipment has been in constant use. In a patent specification dated March 18, 1846, there is mention of an inflatable rubber swimming-belt and "boat cloak", the latter resembling the modern yachting coats which have a concealed inflatable lining. Inflatable or air-tight life-preserving pillows, cushions, luggage cases, and satchels were laid on, sat on, and carried by most sea travellers.

At the Great Exhibition 1851, a self-inflating pontoon was exhibited, the construction of which was similar to that of lifeboats already used. Separate fabric chambers, each

* Later in this article a new launching device is described and this provides for easier boarding by passengers.

FIG. 1 (*left*). Diagram showing the details of a thirty-man-liferaft.

FIG. 2 (*right*). Liferafts for 240 people in the space occupied by one lifeboat. A mass-launching installation.

with its own air inlet tube and caoutchouc whalebone stiffener, formed the main buoyant casing. The boat could be folded for transportation, but the description "self-inflating" was justified by reason of the inrush of air into the compartments as the structure was drawn open.

Reginald Foster Dagnall, whose initials (R.F.D.) are today the name of the company he founded in 1934, was the man who designed the first truly self-inflating rubber dinghies. On a Surrey pond in 1919 he tested experimental models of inflatable rubber boats which he himself had made. These boats were intended for pleasure only, but they were to be the forerunner of the modern liferaft. Between the wars he interested himself primarily in the design and production of dirigibles of various kinds.

But at the same time, and working with another designer he evolved a salvage and life-saving dinghy. It was in the form of an inflatable rubber ring with a fabric floor, and its job was to act as a raft for the crew and as a marker-buoy for the "ditched" aircraft. As the aircraft hit the water the dinghy inflated by means of an automatically operated gas cylinder, and the aircraft, attached by cables to the dinghy, sank beneath it and remained suspended, ready for salvaging. The crew climbed into the dinghy to await rescue. Later, when aircraft were made in metal instead of wood, the machine was allowed to break free from the dinghy—there being little point in salvage—and refinements were added to the dinghy for the benefit of the survivors.

THE PRESENT

Where aircraft are concerned, it is difficult to imagine a more suitable form of buoyant survival equipment. Stowed, the 26-man liferaft made by R.F.D. takes up no more space than a large suitcase and weighs approximately 108 lb. But the sea traveller—and indeed, the uninitiated ship's crew—often ask what advantages the inflatable liferaft has over the ship's lifeboat.

The following abstracts from reports of rescues give some of the reasons for the trend towards this new means of life-saving. The first report shows clearly the advantages of the flexibility inherent in inflatable liferafts.

"At one hour before dawn, in gale-force winds and heavy seas, the Grimsby trawler *Northern Crown* crashed on the Gant rock off the coast of Iceland, and immediately began to sink. Seconds later, as the crew were about to lower the port (leeward) lifeboat, it was crushed under a heavy wave and swept away. The crew went to the starboard boat, and had hardly lowered it to the rail when it was struck and stove in by another high sea.

"The *Northern Crown* was by this time well down by the stern and sinking fast. One by one the crew boarded the now inflated liferafts and cut them adrift. An hour or so later the Icelandic fishery protection vessel *Thor* came alongside, and the liferaft crews climbed aboard. The *Thor* reported that during the whole of the rescue the wind was at full gale force 10, with extremely heavy

seas and swell. Despite this, the operation was carried out without a single injury—or even a case of sea-sickness—from the abandoning of the *Northern Crown* to the boarding of the *Thor*."

* * *

"At about 19.00 hours in a moderate sea and wind force 4, the trawlers *St Celestin* and *Arctic Viking* collided. Immediately the *St Celestin* began to sink, and within five minutes of the collision, she had disappeared.

"The sinking occurred so swiftly that none of the crew had time even to reach their life-jackets, and launching the lifeboats was out of the question. The port liferaft was thrown from its bridge stowage; the line was pulled and within three or four seconds—before the liferaft had fully inflated—the crew were jumping from 15 to 20 feet on to its open but still inflating hull. It was a 10-man liferaft, but the final rescuers found sixteen men in it and three hanging on to the life-line around it."

* * *

"The M.V. *Gudrun*, in heavy seas (force 8 to 9 gale), was struck by a wave which completely smashed the wheel-house and threw the boat on its side. It began to sink immediately. The raft was inflated and four men managed to board it before it drifted from the wreck. About three hours later they were thrown up on the beach. The liferaft was manufactured nine years earlier and withstood the terrific onslaught of the sea conditions; none of the inflated portions of the liferaft was damaged in any way. On questioning, the survivors and the ship owners said they were very pleased with the liferaft and that no other boat would have lived in the heavy seas."

* * *

"The motor fishing vessel No. 1018 stranded on the Mull of Kintyre at about 3 a.m., when navigating in thick fog. There was a heavy following sea at the time she hit the Dunaverty Rock. The inflatable liferaft was dropped over the quarter. It inflated at once, and the crew boarded it from the deck and cut the painter. The raft drifted towards the shore in a rough sea, and bumped heavily on the dangerous rock outcrop, but it suffered no apparent damage."

* * *

"Without so much as getting wet, the entire crew of the Seine-net fishing vessel *Jane Jorgensen* which sank near the Ling Bank off the Norwegian coast boarded their liferaft, drifted for 15 hours in heavy seas and swell with winds of between force 5 and 7. Provisions were eaten and, by the light of their lifebuoy lights, some of the crew played cards. Others, spreading blankets brought from the ship, slept soundly. One of the comments made, after the final rescue by the *Ursula Schulte*, was that the liferaft rode the heavy seas very well, and that every survivor was comfortable all the time."

Since the time of the First World War, rubber-proofed two-ply and three-ply cotton textile has been used in the manufacture of liferafts—or "dinghies", as they were then called. To provide the optimum tensile strength and tear-resistance; the plies are arranged so that (with a three-ply textile) the warp runs parallel to the length of the material

FIGS 3, 4, 5, 6 (*left*). A liferaft inflates from its fibre-glass container.

FIG. 7 (*right*). An R.F.D. liferaft being installed in the port wing of a Bristol Britannia. Inflation is by remote control from inside the fuselage.

on the top and bottom plies and at forty-five degrees to this angle in the middle or "bias" ply.

The proofing is normally natural rubber, and, on a gas-holding fabric such as is used for the buoyancy chambers, many separate coats of proofing rubber are applied between each ply of textile and to the two outer surfaces.

Recently, true synthetics have been employed in the manufacture of liferafts, notably nylon and terylene. They are from two to two and a half times as strong, weight for weight, as the best cottons. A gradual change in proofing material is also coming about, and here one of the neoprenes and a synthetic rubber in the butadiene-styrene class are coming into use.

The problem of conspicuousness for air/sea rescue operations is one which has invited many answers. Exhaustive tests have been carried out under varying conditions, and there seems to be little doubt that the fluorescent canopy is the most satisfactory so far. The orange fluorescent canopies are prepared at the proofing stage by superimposing several coats of fluorescent pigment on to a white proofing material. Thus the fluorescence which is activated by ultra-violet light is augmented by pure reflected light from the white base. This type of canopy has a great advantage in twilight conditions, when ultra-violet outweighs visible light. Tests have also shown that even when a fluorescent canopy has faded it still stands out distinctly beside a non-fluorescent canopy. The only known drawback to the fluorescent pigment is that it does fade more quickly than the non-fluorescent.

But with air/sea rescue operations as efficient as they are today, it is unlikely that any liferaft will remain unsighted for more than four or five days, and the fluorescence remains active for many times this period.

THE FUTURE

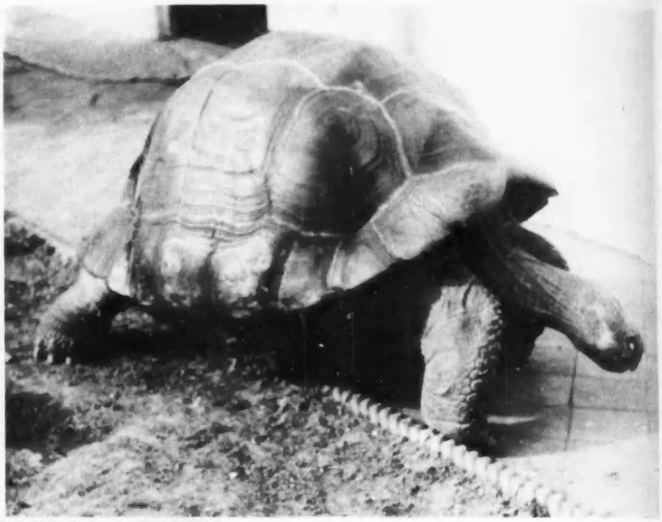
Necessity has never been more a mother of invention than in the history of inflatable liferafts. And with discoveries just beyond man's fingertips which will carry him out of his normal orbits and at speeds as yet only achieved by unmanned vehicles, there must come the necessity for fresh thinking in terms of survival at sea. In less other-worldly matters, there is a constant *cri de cœur* from the airlines for lighter accessories to make room for greater pay-loads, and manufacturers are driven constantly to look ahead for even lighter yet equally strong textiles.

The immediate future, in the more homely realms of the sea, will bring radical changes in life-saving methods on passenger-carrying vessels. A new method of launching ship's liferafts, already adopted by one shipping company, was demonstrated at the beginning of this year for the Ministry of Transport and Civil Aviation. On fishing vessels, and where passengers are not carried, it has been possible for the crew to jump from the deck to the liferaft on the water. With the approach of the 1960 International Convention for the Safety of Lives at Sea, and the possibility that inflatable liferafts will become compulsory equipment on passenger vessels as a result of it, it is obvious that other means of boarding must be provided to allow for the very young and the elderly. The system calls for a single-arm davit which picks up a 'liferaft' in its valise; the acting of lifting it from the deck pulls the inflation cord and inflates the raft. The passengers can then simply walk from the deck into the liferaft. When it is loaded the davit operator lowers the liferaft to the water. As it touches the water an occupant of the liferaft pulls a cord which releases the lifting hook and the davit prepares for launching another liferaft in the same way. By this means, one davit can look after many times the number of passengers previously lowered in ships' lifeboats. In this particular demonstration, one davit alone lowered three rafts (60 survivors) to the water in well under 10 minutes. It will be seen that a battery of such davits could easily clear a vessel of all its passengers in a very few minutes.

To sum up, the inflatable liferaft is earning itself a reputation amongst those whose way of life takes them on or over the sea. Its past has been impressive. Its present is a period of new approach. Its future could mean virtually an end to the loss of life at sea.

CAN THE GIANT TORTOISE SURVIVE?

PHILIP STREET



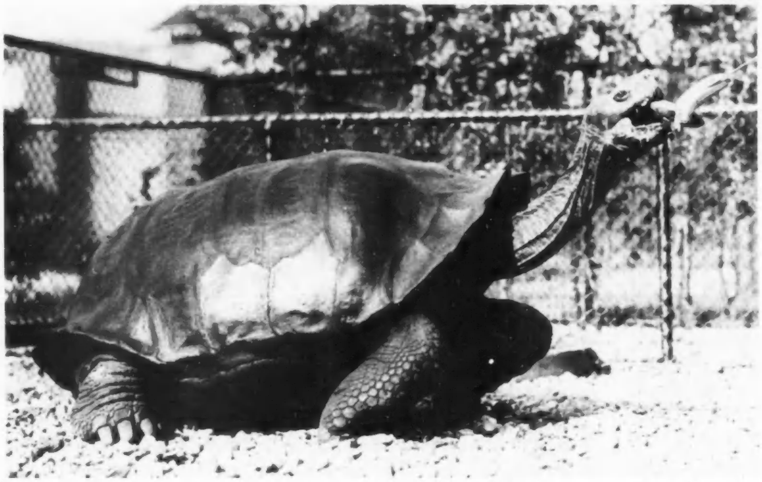


FIG. 1 (*above*). A Giant Tortoise of the Indian Ocean species (*Testudo gigantea*) at the London Zoo in March 1956.

FIG. 2 (*left*). A Thin-shelled Tortoise (*Testudo microphyes*) from Central Albemarle Island, one of the Galapagos group.

The giant tortoises are among the earth's oldest inhabitants. They date from a time long before the great Age of Reptiles, when the unwieldy dinosaurs and their numerous kin ruled the earth. Most of their contemporaries and many of their successors have long since become extinct, leaving only fossil records for evidence of their existence, but the tortoises still exist, though their position is far from secure. Having withstood the natural challenges of countless millions of years, they now face extinction at the hands of modern man.

Often the present-day distribution of an animal only makes sense if we know its remote history, and this is particularly true of the giant tortoises. They are now found only in two widely separated island groups, the Galapagos Islands situated in the Pacific some 500 miles off the coast of Ecuador, and in the Aldabra, Seychelles, and Mascarene island groups in the western Indian Ocean. In much earlier times, however, giant tortoises were widely distributed throughout many tropical and subtropical parts of the world. Here they succumbed in the course of time to various predators. That they survived in these island groups long enough for man to become acquainted with them is due to the fact that there were no predators. Consequently they were able to flourish to the limits of the available food supply. Despite their wide geographical separation, the histories of the two groups in the centuries following their discovery have been strangely parallel.

THE GALAPAGOS TORTOISES EXPLOITED FOR FOOD

It was a bad day for Galapagos tortoises when Fray Tomas de Berlanga, a Spanish explorer, discovered the Galapagos Islands in 1535. So numerous were the tortoises at this time that the islands were named after them, galapagos being the Spanish word for tortoise. They were soon found to be good to eat, and the Galapagos Islands became a regular port of call for mariners in the Pacific. Here they were able to replenish their water-barrels and their larders.

Dampier, writing of the Galapagos Islands in 1697, tells us that "the land turtles are so numerous that five or six hundred men might subsist on them alone for several months, without any other sort of provision. They are extraordinarily large and fat, and so sweet that no pullet eats more pleasantly."

In the days before refrigerators and cold storage the tortoises had, unfortunately for themselves, one great advantage. Provided they were kept fairly cool and moist, and their shells were not damaged, they would live quite well for a year or more in a ship's hold without eating, and

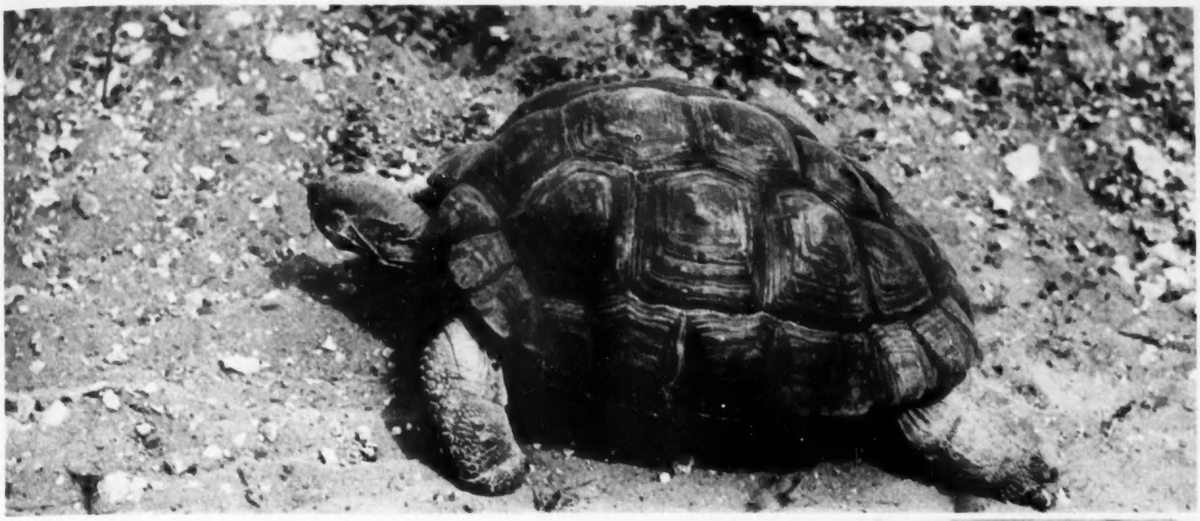


FIG. 3 (*above*). A Porter's Blackish Tortoise (*Testudo nigrita*) from Indefatigable Island, one of the Galapagos group.

FIG. 4 (*right*). A Giant Tortoise of the Indian Ocean species (*Testudo gigantea*) at the London Zoo in March 1956.

(Photographs 1 and 4 are the author's copyright, 2 and 3 that of the Zoological Society of London)

were therefore a perfect form of food to carry on a long voyage. The cook merely killed a tortoise whenever fresh meat was required.

Captain Porter, describing a call at the Galapagos Islands in the early days of the 19th century, tells us that "in four days we had as many on board as would weigh about fourteen tons. They were piled up on the quarter-deck for a few days with an awning spread over to shield them from the sun, which renders them very restless, in order that they might have time to discharge the contents of their stomachs; after which they were stowed away below as you would stow any other provisions, and used as occasion required. No description of stock is so convenient for ships to take to sea as the tortoises of these islands. They require no provision or water for a year, nor is any further attention to them necessary than that their shells should be preserved unbroken."

THE INDIAN OCEAN SPECIES

On the other side of the world, the Indian Ocean giant tortoises had been discovered at about the same time as those of the Galapagos Islands. Leguat, writing of the Island of Rodriguez in 1691, has recorded that "there are such plenty of land turtles in this isle that sometimes you see two or three thousand of them in a flock, so that you may go above a hundred paces on their backs".

Like their Galapagos cousins, they, too, were exploited for food without thought for their ultimate preservation. Some idea of the enormous numbers that went into the cooking-pot may be gained from the fact that in an eighteen-month period in 1759–60 no fewer than 30,000 tortoises were taken from Rodriguez alone.

In another 100 years not a tortoise was to be found either on Rodriguez or on several of the other one-time heavily populated islands. Fortunately, though, large numbers still existed on Aldabra, and the folly of complete extermination was realised in the nick of time. Islands whose populations had been wiped out or seriously reduced were restocked from Aldabra, and indiscriminate slaughter forbidden. Farmers in the Seychelles Islands now keep many tortoises in a state of semi-domestication.

Originally each island had its own distinct species. Many of these were, of course, lost altogether, while the remainder have been crossed with each other through the movements from one island to another. As a result all the giant tortoises of the Indian Ocean are now classed as one species, *Testudo gigantea*, which, fortunately, seems quite safe from extinction.

All giant tortoises are strictly vegetarian, but whereas the Indian Ocean types had an abundance of available food, the Galapagos Islands are extremely dry and barren, many of them having no other water supply than that caught in temporary pools from irregular rainfall. Only a few of the larger islands have springs, and even these are located in the almost inaccessible interior regions, approachable only after an arduous trek across rocks and boulders. Succulent cacti and coarse grasses were therefore the only food available for the tortoises; the sharp spines of the cacti did not seem to bother them.

DARWIN'S REPORT ON THE GALAPAGOS GIANTS

During the voyage of the *Beagle* Darwin visited the Galapagos Islands in 1835. Even then, after centuries of indiscriminate slaughter, the tortoises were still quite numerous. He was deeply impressed with the "huge reptiles, surrounded by black lava, leafless shrubs, and large cacti that seemed to my fancy like some antediluvian animals".

He goes on to describe their journeys after water. "The tortoise is very fond of water, drinking large quantities, and wallowing in the mud. The larger islands alone possess springs, and these are always situated towards the central parts, and at a considerable height. Therefore the tortoises which frequent the lower districts are obliged to travel from a long distance when thirsty. Hence, broad and well-beaten paths branch off in every direction from the wells down to the sea-coasts; and the Spaniards, by following them up, first discovered the watering-places. When I landed at Chatham Island, I could not imagine what animal travelled so methodically along well-chosen tracks. Near the springs it was a curious spectacle to behold many of these huge creatures, one set eagerly travelling onwards with outstretched necks, and another set returning after having drunk their fill. When the tortoise arrives at the spring, quite regardless of any spectator, he buries his head in the water above his eyes, and greedily swallows great mouthfuls, at the rate of about ten in a minute."

EXPLOITATION FOR OIL

Through the 19th century the Galapagos tortoises were less fortunate than those of the Indian Ocean. With no time to recover from the depredations of the 17th- and 18th-century mariners, they became the subject of a second type of exploitation. It was discovered that the fat from a full-grown tortoise could yield about three gallons of clear oil. Consequently, they were again slaughtered in their thousands in a wave of ruthless commercialism. For many years American whalers made a habit of calling at the islands on their way home and picking up as many as 300 tortoises at a time. Since there were several hundred whalers operating at this time, huge numbers must have been taken away over the years.

Darwin refers to the curious method adopted by these oil-hunters to find the best specimens for their purposes. "When a tortoise is caught the man makes a slit in the skin near its tail, so as to see inside its body, whether the fat under the dorsal plate is thick. If it is not, the animal is liberated, and it is said to recover soon from this strange operation."

By the end of the 19th century the tortoises had been completely wiped out on several of the islands, and since each island had its own particular species the loss was serious. In most of the other islands they were becoming rare. But worse was to follow. Although the animals were no longer killed either for food or for oil, they still faced a third hazard, for which man was responsible. He had unintentionally introduced rats, cats, and dogs to the islands, escapees from his ships. With nothing to compete with they flourished, attacking the young tortoises and eating the eggs which had been buried in the sand to hatch. Only the full-grown specimens were safe, and as these died off they were not replaced.

THE PROBLEMS OF PRESERVATION

Today the giant tortoise has certainly gone from at least two of the eleven islands that are known once to have had flourishing populations, and in seven others remnants of species are so small that extinction seems virtually certain, if it has not already occurred in several of them. Only on the islands of Indefatigable and Albemarle are they still present in any numbers, and even here the rat and dog threat is very serious. The Albemarle population contains at least five distinct species.

Over the past thirty years the New York Zoological Society have been making great efforts to save the remaining Galapagos species. Transfer of specimens to other areas where conditions might be suitable for breeding seemed the only hope. There was no point in attempting to repopulate islands that had lost their tortoises, a policy that had been so successful with the Indian Ocean tortoises, because every one of the Galapagos Islands was overrun with predators. Other parts must be tried.

Accordingly, in 1928 the Society sent an expedition to the Galapagos Islands to collect a breeding stock. One hundred and eighty specimens were brought home, and subsequently distributed in small groups to various scientific organisations in Bermuda, Honolulu, Arizona, Texas, Louisiana, Florida, and Australia. The idea was a good one, but so far the successes have been very limited. In almost all of these areas the resident predators have proved too much for the young tortoises even when the climate has proved suitable for the eggs to hatch. Only in Bermuda and Florida have there been any real hopes of success. It does seem that unless another area can be found that has both a suitable climate for hatching and an absence of predators, then the Galapagos tortoises will join the large and growing list of animals that have become extinct during the past couple of centuries through man's greed and folly.

Giant tortoises live probably to well over 100 years, and when fully grown they are very heavy. A few years ago London Zoo received what is believed to be one of the largest specimens ever exhibited in captivity, and it turned the scales at over 600 lb.

Large specimens, however, are not necessarily very old. The rate at which a reptile grows depends very much upon the temperature at which it is kept, provided that it is given plenty to eat. A young giant tortoise kept at the same sort of temperature as it would enjoy in its native islands can reach giant size within twenty years from hatching. It will then go on growing for the remainder of its life.

SCIENCE AT THE SERVICE OF YOUNG NATIONS

ABBA EBAN

Minister without Portfolio in the Government of Israel; President of the Weizmann Institute of Science

Mr Eban is organising an International Conference on Science in the Advancement of New States, to be held under the auspices of the Weizmann Institute of Science in Rehovoth near Tel Aviv from August 15 to 30, 1960.

Two great movements of history shape the life and destiny of our times—the scientific revolution with its glittering discoveries and achievements and the emancipation of new nations, emerging one after the other into the light and air of freedom.

Yet these two streams of historic progress seem to be flowing in separate channels. Scientific progress and national liberation go their separate courses with little mutual interaction. Multitudes of people in the newly liberated countries continue to live a life as though the conquests of science have done more to increase man's haunting sense of insecurity than to advance his welfare.

However, science in our time has not only cast a shadow and spread a cloud. It also sheds a great light—the prospect of man's redemption from his basic scarcities and disabilities.

Nuclear and solar energy can offer new sources of power at a time when conventional sources are inevitably beginning to approach exhaustion. While two-thirds of the world's population suffers from the ills and frailties born of malnutrition, the developments of food chemistry and a swifter acceleration of agricultural production and distribution are already theoretically capable of banishing one of the oldest of mankind's scourges.

In medical science, methods have been discovered of combating endemic diseases which have afflicted whole nations for centuries. Advances in air transport and electronic techniques have brought a new accessibility to peoples hitherto cut off from contact with each other and with the achievements of science and technology.

Clearly, science holds a special promise for those nations which have recently achieved their sovereignty and now find themselves confronted by agonising difficulties on the road towards social and economic progress.

For science has reached its most radiant achievements in highly developed countries. Scientific discoveries have been made in those societies which are least in need of added wealth and power and the leadership of the scientific world now rests in the hands of nations which, however good their intentions, cannot always feel the full and poignant urgency of harvesting the new benefits of science without delay.

Moreover, scientists and statesmen inhabit their separate worlds of functional specialisation. Justly exalted by the pursuit of knowledge for its own sake, scientists are not encouraged to feel special responsibility for the fate of human society. On the other hand, leaders of nations—especially of the young emergent nations—are not always equipped by background or experience to appreciate the capacity of science to find a road towards the solution of their most acute national and human problems.

Thus, as we look upon the separate worlds of statescraft and science, we are driven by the logic of our times to the clear necessity of building a bridge between them; to reveal and define the possibilities of science as an instrument for the guidance and fertilisation of national liberation movements.

It is this vision of the interaction between the two major currents of modern history that has led the Weizmann Institute of Science to the decision to convene an international conference with the participation of scientists, economists, political thinkers, social scientists, and representatives of new nations, particularly those concerned with economic and social planning.

The aim of the Conference is expressed in its title: The Role of Science in the Advancement of New States. The topics to be discussed will be: The Impact of Science on the World of today; Energy and Electronics; Science, Water, and Agriculture; Population, Nutrition, and Genetics; Science, Medicine, and Health; Science and Education; Science, Economics, and Politics; Economies and Social Problems of New States. Under these headings, lectures will be delivered by some of the world's leading authorities.

However, the participants at this conference will not be only scientists, but also representatives and delegations of developing countries, particularly from Asia and Africa. Invitations were sent out, and we have reason to believe that government leaders, economists and planners, university and trade union leaders will participate from the Belgian Congo, Burma, Ceylon, Chad, Ethiopia, Ghana, Guinea, India, Iran, the Ivory Coast, Kamerun, Laos, Liberia, Mali, Nepal, Nigeria, the Philippines, Sierra Leone, Singapore, Thailand, Turkey, Vietnam, and British territories in Central and West Africa.

It is not presumptuous for Israel to believe that, precisely because she is small and ill-favoured with natural resources, her experience may be more instructive for other small nations than any example which they could find in the life of rich and powerful countries.

For if a State like Israel can overcome natural scarcity and the limitations of a niggardly geography—surely the courage and self-confidence of other nations in the like conditions will be uplifted.

The pioneer movement of Israel, the original character of her agricultural settlements and the emphasis on science and learning in the tradition of Israel and of the Jewish people, have combined to create an expectation of an Israeli contribution towards the solution of acute problems facing our world and our times.

For the vision of Chaim Weizmann, the founder of both the State and the Institute that bears his name, was of science and statesmanship as the twin instruments serving the progress of a small country which initially lacked all the conditions for the establishment of a flowering society and progressive economy.

THE BOOKSHELF

The Scientist and You

By Sir Henry Tizard, P. Moore, Sir John Russell, Sir Alfred Egerton, M. Kaufman, Sir Harold Hartley, J. F. Coates, C. Dewar, Roy Innes, Margaret Miles. Edited by Maurice Goldsmith (*Blackie & Sons, 1959, 405 pp., 25s.*)

Mr Goldsmith is to be congratulated on the conception and execution of this book, which is a valuable collection of studies of modern science. The book consists of chapters of a reasonable length on many scientific subjects covering chemistry, physics, biology, and engineering, and some bibliography and information on how the young person is to find his or her way into that branch of science or technology to which he or she is most attracted. The bibliography is incomplete, in that it contains only reference to the literature produced by official and professional bodies and omits that wealth of material which has been produced over recent years by industry. A good deal of space is devoted to the question of careers for women, which is probably just as well, because there is no doubt that the interest in science among boys is now becoming well established, but much can still be done for women.

The chapters in themselves would form excellent bases for lectures on any one of the subjects with which this book deals. They are full of information and some of them contain a wealth of valuable data which must have put the authors at much pains to collect. This it particularly noticeable in Sir Harold Hartley's chapter on Energy. Practically all the contributors approach their subjects from the historical point of view, and in one or two cases this has been very well done indeed. This historical approach is to be expected in a book which has the avowed intention of making science interesting to the young person and to those who are spending their lives in non-scientific activities. The historical approach is best done in Dr Coales's chapter, in that he deals more with the position of science in history than, as is usual, the history of his particular science. The history of any particular science, with its dates and names of discoverers, can be as dry as any history of kings, battles, politics, and religion, but a study of science against its historical background of these subjects can always arouse interest in the mind of the general reader. In dealing with the historical approach, too, the contributors have not forgotten that there is a considerable historical background to be found in Eastern culture as well as in the West.

It is clear that all the contributors are concerned with the fact that the fulfilment of various needs of mankind through recent technological advances has left the problem of leisure. They are clearly feeling out for some means whereby mankind can usefully enjoy this freedom from toil. Perhaps they were keeping too closely to their terms of reference in this book, but their suggestions have not been very imaginative. Two or three of the contributors have referred to the "do-it-yourself" ways of using one's leisure time, but this problem needs much deeper thought than this, and it is to be hoped that in his next book Mr Goldsmith will deal with this aspect of the disturbance caused by technological advancement.

The book, of course, should be looked upon as a whole and not discussed chapter by chapter—except that, as already suggested, each chapter may well be used as a basis for lectures. However, Sir Henry Tizard calls for special comment, in that he shows so clearly how necessary it is for this country to interest itself more and more in science and technology—quite apart from any consideration of our competitors in the material field. His well-reasoned and well-written foreword disposes very adequately of those who, like the authors of the report by the Oxford Appointments Board, are beginning to think that we have already trained too many scientists and technologists. Sir Henry is, however, rather less than fair to industry in its interest in science and technology over the past half-century. He makes a passing remark to the effect that the Mond interests engaged in considerable research early in the century, but one should also remember many of the truly altruistic gifts to universities made in the interests of science, such as the gift to Cambridge as early as 1912 so that chemical laboratories might be built, which for many years were known there as "the oil companies' laboratories".

Sir Harold Hartley's chapter is written in his own inimitable, excellent style and, as has already been stated above, is full of the most useful data. One misconception, however, in this chapter, must be corrected. Sir Harold says that "two-thirds of the fuel oil is burnt as crude without refining". This, of course, is quite incorrect and it is difficult to know what Sir Harold had in mind. Sir Harold, however, develops very carefully and thoughtfully the need for the conservation of our energy-producing materials. He emphasises the need for great care in using the fuels for the purposes for which they are best suited—that is, to use oil for vehicles

of all sorts and to develop the production of energy from the atomic nucleus as quickly as possible, so as to conserve oil and coal, which are not inexhaustible. This part of his chapter deserves the greatest attention from those concerned with the energy industries. It is a pity that Dr Kaufman, in his chapter on Materials, did not give similar weight to the question of conservation of materials. There is every need for the scientist and technologist to develop their skills in the conservation of materials which are in daily use. For example, in the 18th century it was not considered worth while to mine copper ores unless they contained at least 15% of copper, whilst this quantity was reduced by the beginning of this century to 5%, and now one is forced to refine copper ores containing only 0·6%. This kind of thing is true of many other ores and it calls for the greatest effort on the part of the scientist and technologist alike in the winning, extraction, and manufacture of the finished articles from these ores of ever diminishing quantity. Sir Harold develops a very interesting theme in his comparison of energy production from fossil fuels and the energy production by nature through crops and animals.

Dr Kaufman's chapter gives an interesting account of many modern materials —plastics, synthetic rubbers, transistors. fertilisers, and so on—but the chapter becomes in the main what such a chapter is very likely to become—that is, a rather tiresome catalogue of materials. Dr Kaufman himself is constrained to ask, "Why all this emphasis on plastics?" and one feels inclined to agree with him. As has already been suggested, it would have been better if he had given some space to the conservation of some of the well known materials.

Dr Coales has treated the very delicate subject of Automation (for that is what it is called, whatever we may think of the word) very well and very carefully. He makes no exaggerated claims for the new electronic devices and he does not leave the reader with any exaggerated ideas of where controlled machinery is likely to lead. He has made it quite clear that automatic machinery is merely an aid to man's activities, relieving him of much of the tedium. He shows the value of the computer in forecasting requirements and in controlling plant movements. He is naturally, like others, concerned with the question of leisure, but I would judge he does not view the forty-hour week with any great terror and would feel that the added production which we can achieve can easily be absorbed by those countries which Sir Harold describes as "the presently developing countries"—a very nice phrase. Dr Coales envisages a steady improvement in the interest in one's craft as man ceases to be concerned with manual effort and as there is a gradual moving up the scale as more professional engineers and scientists are required to invent, improve, and maintain the automatic equipment.

The book as a whole deals with technology rather than science. The fact is that when we speak of the great advances of science we really mean the great advances which technologists have brought about as a result of the work of scientists. Science and technology must go hand in hand, and the technological improvements which Ferranti or International Business Machines bring to the aid of the present-day scientists stand in exactly the same position as the lens-polisher did to the work of Galileo. In this particular book it is the activity of the technologist or the engineer in all his branches which is being described. It is not the chemist who has produced large quantities of plastics, synthetic rubbers, and many other things mentioned by Dr Kaufman, or the new medicines described in the chapter on Medicine, but the chemical engineer. It is not the physicist who has produced the space-rocket, but the engineer.

The book, of course, is not perfect; nothing ever is. The failure, if failure there be, is that the book leaves the non-scientist—I might even call him the "unbeliever"—still retaining the thought that the scientist and the technologist are all very well in their way as producers of materials and, shall we say, as gadgeteers, but not as the editor would like him to believe in his introduction—that science is a branch of knowledge in its own right.

Then there is the obvious difficulty of trying to produce a coherent whole in a book which is built up of chapters prepared by authors who have clearly not collaborated the one with the other. These authors have all produced their own ideas and there is, as a result, a good deal of repetition which might have been eradicated by better editorship, and it is quite possible that Mr Goldsmith would have produced a better book had he obtained the permission of the contributors to make of their contributions a coherent whole written by himself. This, I think, would have made a much more interesting story for the public which Mr Goldsmith is trying to reach.

The book has failed to bring into the subject of science and technology that enthusiasm with which we should like to see such a book fill the non-scientist. Science, as Mr Goldsmith has said, is a branch of knowledge in its own right, and with this I entirely agree, but one fears that those who are not already dedicated to science will hardly be imbued with the spirit of science by the reading of this

book. Mr Goldsmith should produce yet another book on "the scientist and you", showing more of the philosophical outlook of the scientist. This particular book starts with the wrong premise; it has too material an outlook altogether to fill anyone with the spirit of science. Mr Goldsmith says we are not entitled to any particular position of honour in the universe. Humility is all very well in its place, but this book is intended to show how man has conquered the difficulties which he has met on this earth. It is the entirely materialistic outlook of this book which fails to bring out that spirit of dedication which many feel towards science and technology, which is a branch of knowledge and a method of life in itself.

J. A. ORIEL

What is Cybernetics?

By G. T. Guilbaud, translated by Valerie Mackay (*London, Heinemann's Contemporary Science Series, 1959, 126 pp., 10s. 6d.*)

There have been so many vain attempts to unify science that scientists have become quite reluctant to be unified, fearing, with some reason, that this may involve a levelling down rather than up. Academic workers are apprehensive also of any process that threatens to break down the carefully maintained fences between their domains. Perhaps for this reason most of the essays in scientific generalisation and unification have come from detached theoreticians rather than practical experimentalists and the role of natural philosopher has been assumed by several elder and eminent physicists and mathematicians. One of the most provocative events in inter-disciplinary exploration was the publication in 1948 of Prof. Norbert Wiener's "Cybernetics, or Control and Communication in the Animal and the Machine". Since then, the term cybernetics has appeared more and more frequently, often in surprising contexts, sometimes referring to the characters of a transmission line, sometimes to a defect in the human brain, sometimes to a purely theoretical proposition about the behaviour of complex systems.

With characteristic verve and audacity, the French have been the most prolific writers on this novel subject, but in English there have been few texts for the general reader. Apart from Wiener's own second work, "The Human Use of Human Beings", which is a very personal statement of faith and inspiration, the only coherent sources are the five volumes of the Proceedings of the Josiah Macy Junior Foundation Conferences on Cybernetics in America, and the two works by Dr W. Ross Ashby, "Design for

a Brain" and "Introduction to Cybernetics"; both of which are rather formidable treatises even for experienced scientists.

Now, after ten years of general currency the value of cybernetics has been estimated in simple terms by M. Guilbaud, Director of Studies at L'Ecole Pratique des Hautes Etudes in Paris. His clear and modest treatment has been most happily translated by Valerie Mackay, whose husband is himself well known as an expositor of cybernetics in this country. It is rare for a fresh text in one language to preserve its crispness in another, but Mrs Mackay has managed to preserve the original flavour in a truly English idiom with an excellent taste of its own.

The plan of the book is simple and attractive; beginning with a set of definitions of cybernetics and a glance at the history of the term and its implications, there follows a section on control systems with particular emphasis on servo-action and reflexive processes leading to self-regulation and goal-directed behaviour. This section ends with a brief essay on the notion of chance and the important distinction between information and energy in the definition of a system for communication or control. The next section is devoted to the measurement of information, problems of coding and the probabilistic aspects of language and messages which must be distinguished against a background of noise or interference; this section ends with an admirable exhortation to limit consideration even of basic phenomena by well-defined boundaries of relevance in order to avoid meretricious pseudo-philosophical generalisations about "The Universe" with their dangers of infinite regression.

The final section attempts to sort out the fruitful and unifying notions of cybernetics from the sterile chaff of extravagant claims and vague assertions. This is never easy in the early years of a new philosophy, particularly when the popular Press seizes on the construction of electronic computers or models of behaviour as heralding the "Era of Robots", and the author may be pardoned for expressing mainly scepticism about the universal application of cybernetic principles.

The only serious criticism of his approach is that it is sometimes self-contradictory—"Cybernetics is not a super-science" but a "branch of science" and at the same time is "established at a cross roads". Lao-Tse said "the Way and the Goal are one", so perhaps cybernetics can indeed function both as a common highway and a signpost.

The ways of thinking that can be included in cybernetics emerged from the preoccupation with automatic control systems and high-speed computation of the post-war years, but servo-theory and Boolean algebra are only a part of cybernetic equipment. A cybernetician accepts, as a necessary part of communication, that a signal is sent and received, that the observer and the system observed are themselves parts of a complex interacting system, and he is concerned with finding out how to study and control such systems, containing many heterogeneous elements interacting freely through probabilistic, non-linear links. This phrase could be a description of a guided weapon with its launcher and target or of a brain with its history and environment, or of a human society with its traditions and culture, and the laws that are common to such apparently diverse situations are the characteristic domain of the cybernetician.

A universal solvent cannot by definition be held in any container, so it is not surprising that the boundaries of cybernetics are hard to fix. It is certainly true that cyberneticians who claim to special understanding of control theory have not yet learned how to control themselves; the International Association of Cybernetics (which M. Guilbaud does not refer to) has not solved the pressing administrative problem of organising stable multi-disciplinary congresses without splitting into disciplinary sub-sections. Until problems of this sort can be defined and solved, the cyberneticians will be in the same difficulties as any other scientists and cannot offer more than occasional assistance in the simplification of general problems and the identification of common principles.

In spite of his wide range of knowledge and his facility of exposition, M. Guilbaud has not really answered the question posed in his title. He surveys some of the subjects that interest cyberneticians but scarcely refers to a very rapidly developing field of cybernetic interest—the study of the brain, which is perhaps the most serious, exciting, and practical challenge to cybernetic ingenuity and invention. There is a danger that from reading this book without reference to others, the impression might be gained that cybernetics is only an assembly of particularly abstruse and inhuman technicalities. It should not be forgotten that, to paraphrase Ashby, Cybernetics includes, among other essential human functions, the art of getting your own way.

Even a small book deserves some sort of index. There is only one numerical error, on page 80, and only one minor omission; the word "servo" originated as a trade-name for a power-operated vehicle brake.

W. GREY WALTER

Scientific Manpower in Europe

By Edward McCrensky (*Pergamon Press Ltd, 413 pp., 40s. net*)

Now that the Government has decided to make a start, however unconvincing, on a Minister for Science, it would be well if the new Lord Privy Seal were to read this book for himself and not hand it on to his assistants. Lord Hailsham has this at least in common with scientists: he is not prepared to sit down and accept what exists.

Although the book contains a good deal of statistical information, it is not the statistics that form the most interesting feature. It devotes most of its pages to comparisons of the conditions existing in various European countries for the recruitment, payment, encouragement, and promotion of the Scientific Civil Services in Europe. The review includes methods of consultation between Government and staff, such as through the Whitley Council; it includes a general chapter on the education of engineers and scientists, including interesting developments at Keele, and the courses on the history and philosophy of science which are given at other universities. In the page on statistics, salaries are compared in dollars, which, of course, is quite unrealistic with the dollar at three to £1. This table does, however, enable one to compare the salaries for different grades of scientific service within the different countries.

Although the book is American, it does stick very closely to its terms of reference in dealing with Europe and does not give very much space or even credit to the American systems of training, recruitment, and pay. In fact, it gives more space to the Russian system than to the American.

Great Britain, on the whole, does not come off too badly in this comparison. Our methods of encouraging young men to take up science and engineering at the universities through grants and scholarships, and also our methods of promotion afterwards, are well thought of. The underlying thought running through this book, however, is that the "Scientific Civil Service" does not get all the encouragement it should in most European countries. This is due, the author suggests, to the fact that the Scientific Civil Service is too closely allied to, is even subordinate to, the normal Civil Service. The latter is responsible, through its political heads, to the masses of the country and is therefore not prepared to move as rapidly or to criticise as keenly the existing state of affairs as is a scientist. The scientists, therefore, feel constantly hampered in their work and in their progress.

He constantly refers to the rigidity of systems of promotion within the Civil Service and the consequent frustration caused by the lack of vacant positions within the "establishment". He also points out that there is in most countries some sort of evasion of the question of promotion by means of what he refers to as "contract service". It rather looks from the book as though the real restraint on recruitment to the Scientific Civil Services is what has become known during the recent election as the "image" of the Civil Service. The system of merit promotion in the British Scientific Civil Service is praised, although the full extent to which this is exercised is not thoroughly brought out.

This is, in fact, a very useful little book for anyone wishing to compare methods tried in the various countries in Europe. Britain, it is true, comes off very well, but there are still a number of methods in use in other countries from a knowledge of which we could benefit. Full details cannot be given in a review of this length, and the book should be bought by any of those directly concerned with this subject. It is pleasant to see that Sir Harry Melville has contributed a foreword.

J. A. ORIEL

Human Biochemical Genetics

By H. Harris (*Cambridge University Press, viii+310 pp., 87s. 6d.*)

Undoubtedly one of the key questions in biology at the present concerns the nature of genes (the units of heredity) and the mechanisms by which their effects are manifested in the protein structures, chemical reactions, and characteristics of the living cell. It is certain that within this broader region lie the answers to such problems as cancer; ageing; the treatment of many diseases; and the successful control of bacteria, viruses, and other parasitic organisms. Enormous strides have been taken in the investigation of the mechanisms of heredity and Dr Harris's book is a good indication both of the complexity of the problems and of the progress that has been made in the last ten years.

This is not a book for the layman. It assumes a considerable background of biochemistry and some knowledge of elementary genetics. Given these, however, it is an admirable, lucid and thoughtful account of our modern knowledge of inherited biochemical differences in humans. Garrod, at the turn of the century, can be said to have begun the study of the inheritance of chemical modifications of organisms by his investigations of a few rare metabolic disorders in humans. In spite of the extraordinary penetration of his understanding and the fact that he was able to enunciate most of the major hypotheses which still serve to carry the subject forward, few other workers were attracted to the investigation. Thus, even as late as 1923, when Garrod produced the second edition of his book, he was only able to describe half a dozen rare conditions in any detail. Rapid development of the subject had to await a more thorough knowledge of intermediary metabolism and of population genetics.

The key stimulus to the modern flowering of effort in this field was undoubtedly Avery's discovery in 1946 that certain characteristics of the pneumonia organism could be transmitted from one cell to another by desoxyribonucleic acid, one of the important constituents of the nucleus, the part of the cell wherein it was known that the apparatus of heredity was concentrated. Since then an enormous effort by biochemists, medical research workers, geneticists, chemists, and biologists has been concentrated on working out the relationship of genetics and biochemistry. Interestingly enough, although human beings might at first sight seem to be unpromising experimental material since they are not available for any but the simplest experimental tests, it has turned out that human biochemical genetics has made some of the key advances in the general field. This is probably because humans exist in very large numbers and because any departure from the normal, especially if it leads to ill health, is at once the subject of intense interest and investigation.

Thus it was Garrod who enunciated what must probably now be regarded as one of the fundamental genetical postulates, that each gene exerts its action by influencing the production of an enzyme, one of the cellular catalysts. In the most extreme case this may result in the catalytic activity being abolished entirely, or almost entirely. The organism is not then able to carry out the particular chemical reaction associated with that catalyst with results of varying degrees of severity according to circumstances. For instance, unusual chemical materials may appear in the urine. Dr Harris describes many examples of this, such as amino acids of various types, especially cystine, which may lead to stone formation, sugars, or various pigments. Another example is the occasional inability to convert the amino acid, tyrosine, into the red, brown, and black pigments that normally colour hair, skin, and eyes. Such individuals are white-haired and pink-eyed—albinos. Other changes that may occur may be the deposition of glycogen, a starch-like material, in the liver, with fatal results, or alterations in the blood proteins so that the individual becomes particularly susceptible to disease.

However, not all changes have such severe results. The well known inherited blood groups are due to the synthesis of particular kinds of molecules related to sugars, which are part of the surface coat of the cell. According to which enzymes are active, one or other of several types of these materials may be made, giving the cells their characteristic property.

A final and most exciting example cited by Dr Harris of the key role being played in these advances by the study of human biochemical genetics is the recent discoveries of the abnormal haemoglobins. Haemoglobin is the red pigment of the blood and carries oxygen to the tissues. It is based on a protein, each molecule of which is made up of two identical half molecules each composed of about 300 amino acids linked together in a particular and, it appears, invariable sequence. In 1949 the American scientist Pauling and his collaborators discovered that one of the anaemias that is particularly prevalent in Africa was due to the presence of an abnormal haemoglobin in the blood. In 1956 the British biochemist Ingram was able to show that this differed from the normal kind only in one single amino acid of the 300 located at one particular part of the molecule. Thus, here we have a situation where the alteration of a gene results in the alteration of a single amino acid in a single protein. The quite startling change in the properties of the haemoglobin which results gives some clue to the problem of how an alteration in a single gene may lead to quite profound changes in the organism as a whole.

These examples are but a small proportion of the large number, of equally fascinating topics dealt with by Dr Harris. Indeed, it is typical of the meteoric progress of the subject that a book of 300 pages is now only long enough to deal fairly briefly with its main branches. To anyone with the necessary background the work can be wholeheartedly recommended as a most excellent summary and critical commentary.

E. M. CROOK

Cybernetics and Management

By Stafford Beer (*London, The English Universities Press, 1959, xviii+214 pp., 25s.*)

Cybernetics was first defined as the science of control in machines, animals, and men. A young inter-discipline, it has been built up on the discoveries and insights of workers in many different fields, some concerned with practical investigations in electronics, for example, and some devoted to theoretical and epistemological questions; there were no courses of training for

the pioneer Cyberneticists. Now, eleven years after Wiener's defining publication, the discipline has reached such a stature that it has commanded the attention of many other scientists and engineers and caused them to consider whether they ought to study its doctrines. The "scientifically educated and imaginative manager" to whom Stafford Beer directs this book is certainly not alone with his questions about the utility of Cybernetics to his work. In such a *milieu*, one might have wished for a justification of Cybernetics in terms similar to those for justifying all general sciences.

When a scientist sets out to solve a problem, his chances of success will be influenced by the orientation he takes to the problem: the assumption he makes, the concepts he employs and (accordingly) the information he recalls when thinking about it. This is to say one is influenced by one's general training. As a general discipline of control systems, Cybernetics might be expected to provide appropriate orientation for the solution of problems of management. However, a frame of reference and a collection of knowledge about other systems do not constitute a solution to a novel problem. A lot of specific effort goes into the tasks of answering particular questions. Accordingly it may be quite natural for practical men, impressed by the importance of particular detail, to overlook the comparable importance of a general discipline.

Beer's method of treating those who are concerned to evaluate Cybernetics has been to tell about its achievements, its logical basis, its status as a science, and the orientation it provides. As one of the British pioneers in the field, he is in a good position to expound on the topic.

The measure of the social importance of Cybernetics, according to Beer, is the backwardness of society's present outlook on control. Control is an attribute of a system, which is any collection of parts connected in some way. Biological systems are valuable models for Industrial Cyberneticists, because they demonstrate control methods of quite subtle types. They show goal-seeking behaviour and maintain equilibria against varying disturbances. Beer proposes that all such systems should be known as "homeostats" and suggests that an industrial system is fruitfully regarded as an "homeostat".

The main target of Industrial Cybernetics is ". . . a control device which seeks an optimum homeostatic strategy, which amplifies the intelligence of its human controllers, which learns from its own unfolding experience and which adapts itself to its environment". If this seems close to a specification for a skilled human staff, the effect may be deliberate, for Beer specifically denies that Industrial Cybernetics is merely concerned with automation.

As advertised on its jacket, the book gives a general exposition of Cybernetics. It also gives a more detailed account of certain concepts from the field and of some interesting original contributions by its author. The marriage of generality and detail is not always happy, although the author has helped the reader by providing a preface, an orienting chapter, and a connective summary for each of the four parts into which the text is divided. Thus it may be difficult for the novice to distinguish Cybernetics from Beer. For instance, he will gain the impression that Beer's conception of the discipline as concerned primarily with control in exceedingly complex probabilistic systems is the generally accepted one, which it is not. Nonetheless, though its parts vary in generality, the book is authoritative, thought-provoking and relevant.

The text is lucidly, sometimes delightfully, written and well printed. It is well indexed and the division of topics is commendable. Certainly the book should cause artists in the field to think more about the science of control.

J. A. EASTERBROOK

The White Road

By L. P. Kirwan (*London, Hollis & Carter, x+374 pp. 30s.*)

This survey of Polar exploration is a valiant attempt to sketch its history from the Vikings to Fuchs, and to do it in 360 pages was a formidable task.

There are two unusual features about it. Both Polar regions are dealt with at the same time in as strict a chronological sequence as possible, and special emphasis is laid on the motives for exploration in all their changing variety throughout the centuries. The result is an old subject in a new setting.

The need for brevity has limited the scope for pen pictures of the deeds and personalities of the great names of the past. Care has been taken, however, to give prominence to those who have not been given full attention hitherto. One example is the life and exploits of the Russian naval captain, Bellingshausen.

There is firmness but due restraint in writing of the disputed facts of the first discovery of the Graham Land (Palmer Land) peninsula, still a point of contention between British and American historians. The book is singularly free from bias, either personal or national, but attention must be called to one rather unhappy misrepresentation, which occurs in the chapter headed "The Race for the South Pole."

Influenced perhaps by the faulty sequence in the film, *Scott of the Antarctic*, the author states that on receipt of a cable from Amundsen from Madeira saying he was going to the Antarctic, Scott had difficulty in restraining the anger of his men. This was not so.

Scott had already guessed that, as the *Fram* had all the sledge-dogs aboard, but he assumed, as did the rest of the world, that she was bound for the Weddell Sea. No one suspected that she was secretly going to a base comparatively close to the one advertised by the British party.

Even that secrecy was not seriously objected to by Scott and his men, it was the intention behind it which rankled. It is not generally realised that had it not been for the accidental discovery of the *Fram* by the *Terra Nova* the "race to the Pole" would have been known to the whole world but not to Scott and his party, the sole competitors.

The character of Scott is better shown if we contrast the dozen lines in his diary on receipt of that news with the fulminations of Peary when, on his return from the North Pole he found, as he thought at the time, that he had been secretly forestalled by Cook a year earlier.

Apart for this small blemish the book seems to be accurate and balanced.

The prodigious activity in the Polar regions of recent years has had to be telescoped but the final chapter deals fairly with the new significance of those regions as a result of the advance of science.

The style suffers somewhat from a tendency to long sentences. The illustrations are few but well chosen, the maps are inadequate and in the first one there seeems to be a mistake as to where the New Siberian Islands are. A book for the Polar expert perhaps, rather than the general reader.

F. DEBENHAM

Studies in Crystal Physics

By M. A. Jawson (*London, Butterworths 1959, 42 pp., 10s. 6d.*)

This small monograph consists of four brief articles published in 1958 in *Research*, each forming a chapter, with a fifth added. The five chapters cover (1) some properties of lattices (2) imperfections (3) x-ray diffraction (4) Martinsite phase change (5) thermodynamics of solids. The treatment is at a level which can be appreciated by the third year honours student in Physics, Chemistry, Mineralogy or Metallurgy who has already received some introduction to crystal physics.

While the subjects selected and the material content is admirably suited to articles in a journal, as a book the bias is wrong. For each article, understandably, was concerned with one of the local fields in which the author has himself published, but this results in a rather narrow content for a book. Nevertheless each chapter is an admirable summary in itself in its own very restricted field.

The new added fifth chapter, on the thermodynamic behaviour of solids, appeals far more to your reviewer than do the four previously published articles.

This is a useful teaching monograph, especially for the overloaded student who seeks a brief summary of what is really a formidably difficult subject with a vast literature.

S. TOLANSKY

Research for Industry

Department of Scientific and Industrial Research (*H.M.S.O., 1958, 135 pp., 7s. 6d.*)

This volume deals with the work of the Industrial Research Associations, and in particular embodies a report by the Industrial Grants Committee to the Council for Scientific and Industrial Research, reviewing the policy on which grants are based. The committee recall that prior to the 1939–45 war, Government aid to research associations was based on the assumption that they would eventually support themselves. However, in 1945, the then Lord President of the Council, Mr Herbert Morrison, laid down the principle that "now it has been decided that in the national interest, grants to research associations will form a *permanent* [our italics] part of the activities of the Department". The principle underlying the granting of this aid, which is awarded annually over a period of five years, is of a basic block grant by the Government, supplemented by incentive payments, which vary according to the income which an association can raise from its members. While such a system must be flexible and particularly generous to new associations, the policy since 1951 has been that the incentive grant should gradually reduce and cease altogether as an association reaches an appropriate size. The committee noted that the ratio of Government grants to industrial income had now fallen from 1 : 1·65 to 1 : 2·5, and that while over the next quinquennium the total Government grant would rise by a third over 1954–9, the total grant-earning income would rise by nearly a half. An important consideration for the DSIR has inevitably to be that an association should have an adequate proportion of basic research in its programme. Basic research is, therefore, a condition of grant-aid, and it is not without interest and scarcely a coincidence that whereas the average ratio of grant-aid to total income stands at about 25%, some 28% of the associations' total efforts is devoted to basic research.

The case for Government-aided research which is co-operatively financed can be sustained on a number of general considerations. Not all of these can be easily evaluated in terms of money, although conclusive illustrations of the fruits of applied research are to hand in this volume. Thus, investigations into heat-utilisation and washing processes have resulted in savings of some £200,000 per annum, against a total annual income for the association concerned of only £40,000 per annum. While thanks to research into control systems in the textile field, an installation costing £3000 has achieved a saving of £40,000 annually, and an outlay of £1000 on a control device has been recovered as the result of using it for a single night. Examples could be multiplied. Yet whilst readers will readily echo the committee's verdict: "We are greatly impressed with the rapid progress of research associations towards maturity and with the rising quality of the research they carry out and the services they give to industry", there is a danger of complacency. True, expenditure on the research associations may be complementary to that of private industry, but the fact that an expenditure by private industry on the research associations of nearly £5 million has to be seen against an outlay on research and development by private industry within its own sector of about £60 million, is not so much, as one contributor to this volume states, "some indication of the important part which they (the associations) now play in the national scientific effort", but rather proof, as he also concedes, that the expenditure by British industry on civil research is still far too small.

A Short History of Scientific Ideas to 1900

By Charles Singer (*Oxford, The Clarendon Press, 1959, xviii+525 pp., 35s. net.*)

Scholars familiar with Charles Singer's "Short History of Science", which

appeared in 1941, will recognise an old friend in a new guise in this new book. It is, as the author states, rather more than a new edition of the original work: as the title indicates, the emphasis is more on ideas and philosophical considerations. There are more illustrations—though all are interesting, not all are directly helpful to the argument—and economic and technological aspects receive rather greater attention.

The planning of such a book presents enormous difficulties, and the final choice must necessarily be subjective. As a matter of personal choice, the reviewer would have preferred to see greater emphasis on recent developments and less on science in antiquity: the dramatically productive second half of the 19th century claims only one-fifth of the total. The first half of this section, dealing with physics, chemistry, and astronomy, was written by Prof. H. Dingle. As one would expect, this is very competently done, but one cannot help wishing that he had written at greater length. This is, however, a minor criticism; Prof. Singer's plan is at least consistent and—much more to the point—based upon a long life devoted to the history of science and medicine. Save to those who know his seemingly perpetual vigour, it will surely come as a surprise to know that this masterly conspectus of the evolution of scientific thought was prepared in the author's eighty-second year.

In its new form the book maintains the very high standard of scholarship that the author has set for so long. Technically, he is correct in his claim that the text is elementary and demands no more knowledge than a secondary education should impart: nevertheless it ranges so widely through human knowledge and raises so many philosophical points that it is optimistic to hope that the average product of modern secondary school education will embark upon the book and stay the course. How much richer the world would be were this not so. T. I. WILLIAMS

Philips' Plastic Relief Model of the British Isles

This model should be welcomed as indicating an approach—however timid—by another British cartographic organisation into the exciting field of plastic relief maps.

This small model—12 in. × 9 in.—is at a linear scale of 1/5 million (80 miles to the inch): the vertical scale is not described though considerable vertical exaggeration is involved. The model is printed in conventional layer tints to show altitude and has a small and curious selection of place names (Cambridge but not Oxford: Weymouth but not Bournemouth) in somewhat old-fashioned type. There are some heavy red lines that presumably represent main railways, though the legend is secret about this.

The model has been reproduced by the technique of printing a flat plastic sheet and then "vacuum forming" it over a mould taken from a three-dimensional model. And as a technical sample it is adequate.

But who is to use this model and for what? The correlation of altitude tints with three-dimentional relief is unimaginative and being fully coloured a teacher cannot himself colour up other distributions such as geology or rainfall.

Being not very good as a map, nor very useful as a model, it is difficult to know who will pay 10*s*. 6*d*. for it—almost the cost of one Philips' Modern School Atlas of the whole world: a cost ratio of about 100:1.

Russian Patents Gazette

(*Published by Technical Information Company, Chancery House, Chancery Lane, W.C.2.*

About 2% of scientists (and an unknown, but probably smaller, percentage of technologists) in this country can read technical material published in Russian. We must hope that this deplorable situation will eventually be remedied, but in the meantime, we can only welcome each addition to the growing list of publications which, in one way or another, aim to help our linguistically unenlightened scientists and technologists to keep informed of what the Russians are doing. One of the latest of these publications is *Russian Patents Gazette*, which, as its name implies, covers the wide field of Russian patent literature. As Russian patents are, if anything, even less known than Russian technical journals, this publication deserves a special welcome. It is available either in a comprehensive form, or in two sections, one dealing with general, mechanical and electrical engineering, and the other with chemistry and chemical engineering.

Das Photo-Objektiv (The Camera Lens)

By Dr Hans-Martin Brandt (*Braunschweig, Friedrich Vieweg & Sohn, 1958, 246 pp., 91 illustr., DM 19,80, appr. £1 16s.*)

The author, a university lecturer, training director, and well known as a specialist instructor in his field, has already put the photographers of central Europe in his debt by his earlier introductory work, *Photographie und photographisches Praktikum*. In the present new work he increases our debt, for here he compiles

in the best German tradition of thoroughness and comprehensive survey the variants on the theme of camera-lenses and deals extensively and intensively with all current types and their special application. The book combines the virtues of a trade directory, a book of instruction for at least the apprentice stage, and first-rate reference for the industrial designer as well as the intelligent amateur experimenter. Tables of optical data stress the practical angle of this work. The fact that Italy and Japan are included in the list of countries of current interest to photo-dealers and workers enhances the value of the topical compilation and study considerably because not all data offered here can be regarded as easy to come by in this country or at least, so conveniently and lucidly grouped. J. HORNE

Sixth Special Report from the Select Committee on Estimates, Session 1958–9. DSIR (Observations of the Council for Scientific and Industrial Research). (*H.M.S.O. 9d.*)

It will be recalled that in their fifth report for the session 1957–8, the Select Committee (see DISCOVERY, vol. 19, No. 11, p. 487) examined the working of the DSIR and made a number of recommendations. Much the most important of these was the suggestion that there should be a review by the Government on how far certain specialised laboratories—for example, the Road Research Laboratory and the Water Pollution Research Laboratory—should be removed from the DSIR and placed in the appropriate executive department.

The Council's reply invokes the original principle underlying the establishment of the DSIR, which it claims has been satisfactory and economic, that it should be a scientific agency free from executive responsibility and able to take a detached long-term view. Since, however, the Council also intimates that the Treasury is initiating an inter-departmental review of these particular stations, it is tempting to ask why it is adopting so rigid a position. Perhaps the real reason is not far to seek. For in the same report there is the reply to another Estimates Committee recommendation that "tenders for work to new specifications should be shown to the Road Research Laboratory as a matter of routine"—a recommendation only accepted by the Minister of Transport for projects already prepared in consultation between the Laboratory and the Minister's Department. Having regard to this, and to what has recently become known about the research basis of the road programme, could it not be that there is a real danger of the Road Research Laboratory's independence being "swamped" within a Ministry, while as part of the DSIR it is free to speak its mind? Indeed, is there not in many fields a similar conflict between administrative efficiency and scientific freedom?

Strange World of the Moon

By V. A. Firsoff (*Hutchinson, 1959, 226 pp., 25s.*)

During recent years, several popular books about the Moon have appeared. Generally the Moon is presented as a dead world, totally devoid of atmosphere and water, and where life of any sort—even primitive vegetation—is out of the question.

V. A. Firsoff, himself an experienced lunar observer, holds views which are in many ways decidedly unorthodox. He believes, for instance, that the Moon was once an independent planetary body which was captured and lost several times during its history, until finally captured by the Earth during the Tertiary Period. This idea is reached from studies of the surface features of both Earth and Moon, and is controversial in the highest degree. Other sections which will give rise to much argument concern the possibility of snow on the lunar surface; the suggestion that large seas may exist below the crust; and discussion of the idea that lowly forms of life may survive in favoured localities.

It is always easy to say: "This idea is unorthodox—therefore it must be wrong." To attempt anything of the kind in the present instance would be unwise, since Firsoff has marshalled his arguments with great skill, and has presented a challenge which must be answered. The present reviewer is in strong disagreement with some of the author's theories, but summary dismissal of any of them is quite impossible, since each is presented in an admirably scientific manner.

The book is "popular" inasmuch as it may be followed by the non-technical reader; it must be added that the author writes extremely well, and is always lucid and interesting. The photographs are satisfactorily reproduced, and so are the drawings of lunar surface features, though the latter are on an inconveniently small scale. A mathematical appendix is included for those who wish to follow up the various arguments, and, fortunately, there are reference lists given at the end of each chapter. Misprints are very few, and the whole book is well produced.

The question of the hypothetical lunar atmosphere may be cited as an example of the book's general trend. It is well known that if the Moon has an atmosphere at all, the density must be extremely low, and the author appreciates

this; on the other hand, he believes that a definite mantle exists, with a ground density of perhaps 1/10,000 of that of the Earth's air at sea-level. Such an atmosphere was announced, a decade ago, by the Russian astronomer Y. N. Lipski. More recently the French observers B. Lyot and A. Dollfus have carried out further researches on the same lines, and have not confirmed Lipski's results. On pages 128 and 129, Firsoff discusses the French work, and gives reasons why he believes it not to be conclusive. Whether he is right or wrong, it is clear that his views merit very close consideration.

In short, this is a fascinating book which deserves a place in the library of anyone who is interested in the Moon. The author is deliberately controversial; those who disagree with him in some respects will have every opportunity to say so.

P. MOORE

The Principles of Humane Experimental Technique

By W. M. S. Russell and R. L. Burch (*London, Methuen & Co. Ltd, xvi+ 238 pp., £1 10s.*)

"Violence is the last refuge of the incompetent." Russell and Burch use this quotation from science-fiction writer Isaac Asimov to sum up their case that in the laboratory, humanity goes hand in hand with efficiency. The good scientist tries to treat his experimental animals well and seeks to avoid the use of painful and inhumane techniques, not because he is necessarily a humane man but because he is a good scientist. They also make the point that the type of personality which goes in for inhumanity towards animals is unlikely to make a good experimental biologist.

For those who know the UFAW (Universities Federation for Animal Welfare) Handbook on the Care and Management of Laboratory Animals, it will be enough to state that this new book, also sponsored by UFAW, is to animal experimentation what the UFAW Handbook is to animal husbandry. The twenty-four pages of references, and the twenty-six pages of tabular material on the use of laboratory animals in this country, would alone make it valuable. "Guinea-pig" in ordinary speech has come to be synonymous with "experimental animal": but how many guinea-pigs are in fact used by British laboratories each year? In 1952, the total was less than 200,000, as compared with 1,200,000 mice and 250,000 rats (the list also includes 50 lemmings and 1 tortoise). The decline in popularity of the guinea-pig is due in part to the virtual disappearance of diphtheria in this country, and in part to the development of improved *in vitro* culturing methods for the identification of the tubercle bacillus.

Having marshalled the available facts, Russell and Burch attempt a systematic analysis of animal experimentation from the humanitarian viewpoint. Most of the book is devoted to a discussion of what Russell has called the "Three R's" of humane technique: Reduction in the number of animals used to obtain a given amount of information; Replacement of conscious living higher animals by relatively or absolutely insentient material; and Refinement of procedures, so as to decrease the incidence or severity of inhumanity suffered by those animals which still have to be used.

Principles are derived, and examples drawn, from many different branches of biology. Particularly interesting and useful are the survey of the rapidly developing subject of variance control, and the distinction which is drawn between pain and distress. It is the latter which the humanitarian should be seeking to minimise, so it may be just as important, for instance, to eliminate fear as to eliminate pain.

The over-formalistic approach and terminology of the earlier chapters may put off some readers: this is a pity, since they do not last once the book gets into its stride. I strongly recommend this book to all who do experiments on animals; and I would like to see it made compulsory reading for all anti-vivisectionists.

A. MCLAREN

Digest of Soviet Technology

No. 2, May 1959 (*£6 6s. per annum*)

The Digest of Soviet Technology is published monthly by Engineering Information Service, of Kirkham, Lancashire, and the issue sent for review includes sections on Design and Production (of mechanical engineering plant), Metallurgy, Welding and Foundry Production, Instruments and Automation, and six general abstricts.

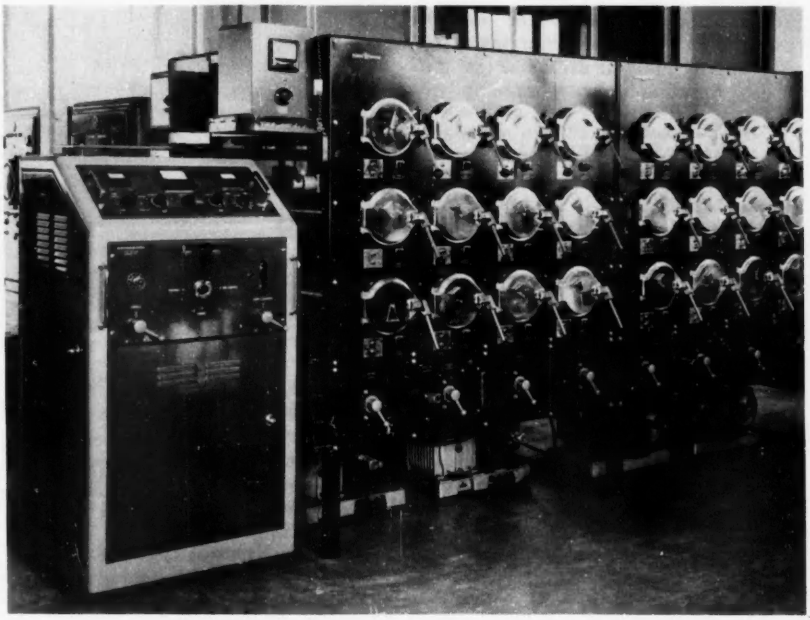
The abstracts in the specimen issue (No. 2, May 1959) are long enough to be useful and, a welcome feature (found in all too few abstracting journals), the occasional line block helps a good deal to make the meaning clear. There are contents lists from Russian journals in the fields mentioned above. The publishers offer full translations of articles from these journals, on a "sharing" basis; the more requests there are, the cheaper each translation becomes. A further service in the journal is a list of recently published Russian inventions.

J. H. M. SYKES

NEW SCIENTIFIC INSTRUMENTS

ARTHUR GARRATT

Manufacturers in this country and abroad are invited to send information about New Scientific Instruments as early as possible to the Editor for review.



High sensitivity leak-detector checking leaks in individual nuclear fuel cans.

Misregister has long been a serious problem in colour printing. The two principal causes are distortion and size variation in the paper due to its being out of equilibrium with the humidity of the pressroom. PATRA announce a **Paper Equilibrium Tester,** the PATRA PET, which checks dimensional stability to 0·005 in. The instrument consists of a sword-shaped Duralumin bar which is thrust up to the hilt into a sample ream of paper through the wrapping. On pressing a lever, two marks are made on one sheet of the paper a precise distance apart. The sample ream is unwrapped and the marked sheet removed and hung in the pressroom for fifteen minutes. The distance between the marks is then measured, using a special device incorporated in the instrument. From the results it can be decided whether or not the stock should be conditioned before use. The PATRA PET is available commercially.

From France comes a **Leak-Detector** of extraordinary sensitivity, claimed by the importers to be the greatest in the world. It operates by detecting helium by a miniature mass spectrometer in proportions as low as 1 in 10^7. This gives a minimum leak-detection rate of 10^{-12} cm.^{3}/sec. It uses two pumping units in the vacuum circuit: a two-stage mechanical pump and a silicone-oil-vapour-diffusion pump cooled by compressed air. These units maintain a vacuum of less than 10^{-6} mm. of mercury in the test cavity. The instrument has particular applications in nuclear engineering and all kinds of pumping equipment. (See photograph.)

Also announced is the **Gammagraph**, an instrument which measures continuously the fall-out of gamma radiation—indoors or out of doors—near a nuclear power station. It operates for a month, without attention, from a car battery. It is completely weather-proof and it is claimed that with its aid local authorities can record gamma radiation fall-out as simply and easily as they now record meteorological data.

In the field of data-processing, **Digitized Measuring Microscopes** are now available. They are fixed microscopes with traversing stages moved by precision micrometer-screws of 1 mm. pitch. They read to one micron and are accurate to about $\pm 2\mu$. The digitiser units are made up of one or more decade units in series, each preceded by a ten to one reduction gear. The first unit is a 1000-division digitiser and this is followed by any number of decade units without any backlash errors being introduced. The entire digitiser is reversible and continuous. Insulating and conducting segments are arranged on cylindrical drums in a binary code and the information is decoded and fed into a serialiser when the read-out switch is operated. The output of the serialiser can be read on indicators and recorded on a typewriter punched card etc., as required. When a long series of measurements have to be made with a measuring microscope, the digitiser greatly speeds the work and reduces considerably the chance of error.

A new **Zoom Lens** is in production for television cameras using image-orthicon tubes. It has a wide focal range (2 to 40 in.) and thus covers almost every requirement for television. The design is particularly interesting in the respect that it employs aspheric optical components. Machine tools have been developed at a cost of £250,000 to produce aspheric surfaces to profile accuracies as good as high-grade spherical surfaces (within 10 μin.).

A new **Automatic Transistor Assembly** system has been developed in the United States which delivers computer transistors at the rate of 1800 per hour. It assembles six transistor parts five times as fast as the semi-automatic methods in current use. The machine covers 500 ft.^{2} and consists of nine units joined by a conveyor. It is claimed that it is the first automatic means of making n-p-n alloy junction transistors and it can be modified to produce any type of alloy transistor.

A new technique for storing information, the **Twistor Permanent Magnet Memory,** has been developed and is now going into mass production. A "twistor" works on the principle that a wire with twisted magnetisation can be switched either by a current passing along the wire or passing along a wire perpendicular to it. A twistor consists of a copper wire, 0·003 in. diameter around which is wrapped a spiral of magnetic (Molyperm-alloy) tape 0·0035 in. wide and 0·0003 in. thick. Machines to produce twistor at a rate of 300 ft./hr. have been developed. Memory modules are made up of arrays of tiny permanent bar magnets formed by photo-etching sheet magnetic material

bonded to plastic card which is superimposed on a twistor-conductor grid-sensing element. This element senses the presence or absence of a field from the permanent magnet which inhibits the action of an electrical pulse through a "word-coil". If there is no magnet at a given intersection of word-coil and twistor, a corresponding pulse is generated in the twistor and read out. If a magnet is present, no twistor pulse is produced and no signal is read out. The system is an electro-magnetic analogy of an ordinary punched card and can thus be used for computer programming.

MANUFACTURERS

Paper Equilibrium Tester. Printing, Packaging and Allied Trades Research Association, Leatherhead, Surrey.
Leak-Detector. La Compagnie Française Thomson-Houston, Paris. Importers, Leland Instruments Ltd, London, S.W.1.
Gammagraph. Electronic Instruments Ltd, Richmond, Surrey.
Digitized Measuring Microscopes. Hilger & Watts Ltd, London, N.W.1.
Zoom Lens. Taylor, Taylor & Hobson, Leicester.
Automatic Transistor Assembly. IBM United Kingdom Ltd, London, W.1.
Twistor Permanent Magnet Memory. Bell Telephone Laboratories Inc., New York, 14.

New Type of Loudspeaker

An electrodynamic loudspeaker has been developed by Mr R. Gamson, an electronic engineer, and Dr Ephraim Frei, Acting Head of the Electronics Department of The Weizmann Institute of Science, Israel.

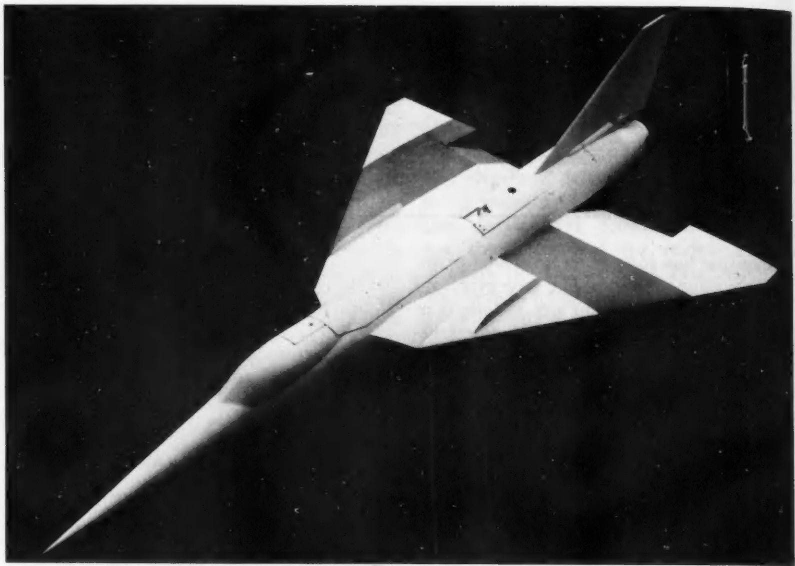
The main outward feature of the new amplifier (known as an Isophase speaker) is its flatness. The paper cone, which at the back of the traditional loudspeaker transmits the sound waves to the air, has disappeared. In the conventional type of loudspeaker the vibrations are received from a mobile coil (a paper cylinder with electrical winding) which vibrates according to the current flowing through it. The paper cylinder moves in a cylindrical air gap contained in the pot magnet.

In the new loudspeaker the mobile coil is replaced by a membrane over whose entire surface a winding is "imprinted" in a zig-zag form. The membrane vibrates in a magnetic field which matches the winding. This field is produced by thin strips of a new type of ferrite magnet of high coercive force.

One of the advantages of the Isophase amplifier is that the membrane swings in unison over its entire area. The phase of the acoustic waves is, therefore, completely true and governed by the phase of the electric current, whereas standing waves generated in the paper cone of the conventional speaker will change phases above 600 cycles.

Owing to its flatness, the new speaker needs much less space than the traditional type. Nevertheless, its response is excellent: it generally behaves like an electrostatic speaker in high notes and like an electrodynamic one in low notes. It is hoped that such speakers will be used in high fidelity and stereophonic systems.

The invention has also opened new vistas in the development of headphones and microphones. The system might be applied to design a headphone which can be used as an audiometer. Another possibility is the design of an efficient microphone with a very thin membrane that will not interfere with the radiation field.



The FD2 model in "Araldite" and glasscloth laminate.
(Crown Copyright)

Free Flight Aircraft Models

The Royal Aircraft Establishment, Bedford, has recently released details of aircraft models required for tests on spinning characteristics in free flight. These models are launched from a balloon at a height of about 3000 ft. with controls set to promote a spin, and recovery of the models is investigated by using built-in timing and height-sensitive equipment.

The constructional materials used must allow a high degree of dimensional accuracy, and dimensional stability unaffected by variations in temperature and humidity. They must also be easily repairable and capable of being worked without special tools. Balsa wood was originally employed but models were usually smashed irreparably after each test whereas the present method, using "Araldite" epoxy resins and glasscloth to provide a reinforced plastic, enables models to be used repeatedly, apart from the important advantage of high dimensional stability. One reinforced model was, in fact, found buried 2 ft. in the ground: after 1½ hours' digging it was retrieved undamaged.

Australian Solar Furnace to Test Metals

A special solar furnace now being constructed by Australian scientists in the grounds of Sydney University will be used to test the resistance of metals to temperatures of 3000° to 4000°C. Such tests are highly important for metals needed in the construction of rockets, jet engines, and atomic power plants which are subjected to very high temperatures.

The main feature of the Australian solar furnace will be a 65-ft. four-legged tower which will support a concave paraboloidal mirror 12 ft. in diameter. This mirror will collect sunlight reflected on to it by another mirror—a heliostat—on the ground. From a small laboratory in the tower, the metal or other material to be tested will be lowered, in block form, to a position where solar heat gathered by the concave mirror above can be concentrated on to a small area of its surface.

Scientists hope the furnace will provide a solution to present difficulties in testing metals for heat resistance. Conventional furnace methods of testing are "dirty", as the test material contacts other materials and becomes contaminated, especially if melting occurs. Chemical action helps to cause dissolution. Metals can be tested under "clean" conditions in high vacuum heating, but the method is expensive and involves

Norstedt's Demonstration Set for General Physics.

problems such as escaping gases from the test materials preventing maintenance of a high vacuum.

Science Demonstration Sets from Sweden

The Educational Supply Association Ltd organised a demonstration of Science Demonstration Sets designed by Dr Lindstrom of Norstedt Skolavdelning, Stockholm, Sweden.

Here, in stout wooden boxes, are Meccano-like miniature laboratories. Each one is designed to allow a reasonably large variety of experiments to be demonstrated to classes. All the parts are easily assembled, and the assembly is done in front of the students.

For the less experienced and less knowledgeable teacher there are very comprehensive manuals which, in fact, give the teacher full details, not only of how to assemble the equipment, and carry out the experiment, but also the teaching-matter he should put over.

The prices of these sets range between £20 and £30. The subjects covered at the moment are: General Physics, Heat, Light, Magnetism and Electricity, Electricity 2, Chemistry, Physiology, Geometry.

The demonstration set for *General Physics*, which costs £28 10*s*. 0*d*., allows about fifty experiments to be carried out. It is suitable for the first and second years of a General Physics course. The components are beautifully finished, with the metal parts in gleaming chrome. It allows the teacher to demonstrate the forces of gravity, friction, pendulums, pulleys, levers, and other experiments with forces. It also contains the material for demonstrating the centre of gravity and balance, the determination of mass, volume, and density, some facts about gases and liquids, and the construction of pumps.

Demonstration sets for *Heat* cost £28 17*s*. 6*d*. This set includes an electric heater, to work off various voltages, AC or DC. In it are the materials for experiments on expansion, the measurement of heat, transmission of heat, specific heat, melting and solidification and boiling.

The demonstration set for *Light* allows the teacher to demonstrate refraction of light, reflection, and the general character of light. It also contains very well designed equipment for showing the characteristics of lenses, and a projection apparatus can be constructed. There is apparatus to demonstrate the working of optical instruments, like the telescope and the microscope. There is also material for experiments with the spectrum and colour.

The demonstration set for *Magnetism and Electricity* costs £28 10*s*. 0*d*. This allows experiments with different sorts of magnets, including the compass and magnetic lines of force. There are various experiments on electric current. Electromagnetism can be demonstrated from a simple electro-magnet to a bell, telegraph and electric motors. The production of heat, induction, electro-chemistry, direct and alternating currents, and· thermo-electricity are also included in the handbook and the components.

The demonstration set for *Electricity 2*, at £31 10*s*. 0*d*., enlarges the potentialities of the set on *Magnetism and Electricity*. It comprises experiments with the telephone, loud-speakers, thermionic valves, and quantitative experiments on electricity.

The demonstration set for *Chemistry* costs £24. The handbook describes nearly a hundred experiments in organic and inorganic chemistry which can be carried out with the apparatus. Although this set is most useful, naturally it is not so revolutionary as those on *Light* and *Magnetism and Electricity*.

The demonstration set on *Physiology*, at £31 10*s*. 0*d*. contains an electric immersion heater, and is designed to carry out fifty physiological experiments. The experiments are both on plant and animal physiology.

Demonstration set for *Geometry* (metric system). (The A.1 set for Lower Classes, £14 10*s*. 0*d*. The A.2 set for Higher Classes, £11 17*s*. 6*d*. The B set for schools with a smaller number of pupils contains the whole course, £13 15*s*. 0*d*.) This set is slightly different from the others, because it consists of shapes which are issued to each member of the class, and they use them to prove practically geometric theorems.

Besides the teachers' demonstration sets, "Class trays" will soon be available. These will contain duplicate material in sets of ten; so that the pupils can carry out the experiments themselves. In the opinion of your reviewer, and those of the science teachers with whom he discussed the material, these sets are both reasonably priced and of great potential value in schools not equipped with efficient laboratories.

It is, on the other hand, a pity that some of the material is not larger, so that it would be visible to all the children in a large classroom.

L. GOULD-MARKS

GEOPHYSICS AND SPACE RESEARCH

By ANGELA CROOME

The Sun and the Van Allen Belts

There is some evidence for thinking that the premature collapse of the radio telemetry from *Explorer VI*, the "paddle-wheel" satellite launched by the Americans last August, may have been due to the high radiation it encountered in the Van Allen zones. It was revealed at the Nice Space Symposium that the satellite's radiation counters registered intensity several times greater than a dosage of 7000 röntgens an hour. The satellite's complex radio system was powered by solar cells protected by only a thin wafer of glass. This may have been insufficient to withstand such massive bombardment of radiation.

However, the satellite's radio continued for long enough to add very considerably to previous knowledge of the structure and detailed behaviour of the Van Allen zones. No less than three distinct experiments were carried out and a minimum of a month's data was obtained. The last observations received from the satellite, on the Minnesota experiment, were those of October 6, almost two months to the day from launching. A number of reports on recent consideration of the Van Allen radiation were given at the symposium. Here follows a summary of the principal points.

It is now clear that the charged particles composing the inner and outer zones are quite different; also that these zones are contrasted in several other ways. The particles in the inner zone appear to be principally protons with some electrons; those in the outer zone are much more numerous but have a much lower energy and are almost certainly electrons of solar origin. Whereas the inner zone remains stable in intensity and position over long periods, the outer zone varies sharply both in its intensity and its position above the Earth, and these changes are often very rapid. The "slot" between the two zones also shifts substantially in association with the outer zone. Altogether it is now obvious that the structure of the zones is much less simple than once seemed possible and that the mechanism responsible for them is highly complicated, though its general reliance on events occurring on the Sun is beyond dispute. For instance, the influence exerted on the zones by an interplanetary magnetic field and by ring currents located at several earth-radii from the Earth's surface must now be taken into account as well as that of the geomagnetic field and possible magnetic fields "frozen" into plasma ejected from the Sun.

The report on the University of Minnesota measurements given by J. R. Winckler traced in detail the effect on the zones of two distinct types of solar storms that occurred while *Explorer VI* was still in radio contact.

(1) *Effect of geomagnetic storm of August 16–18:* This strong storm, which had a sudden commencement at 02.00 UT on August 16, produced an immediate and sensational *depletion* in the radiation in the outer zone. Twenty-four hours after the beginning of the storm *Explorer VI's* counters showed that nearly three-quarters of the radiation previously held in the outer zone had been lost. What happened to this radiation? It appears to have leaked down into the atmosphere where it was lost, causing on the way a spectacular *aurora* which was independently observed by a member of the Minnesota team at a latitude well below the normal auroral zone (57° N).

Immediately after the storm, on August 18, another remarkable observation was made. Not only had the outer zone filled up to give a radiation value equal to the pre-storm count but this was now much exceeded. "A natural conclusion is that somehow in the wake of the storm a portion of the low-energy matter which is normally undetectable was elevated in energy . . . and appeared as an increase in the electron component on the counters".

(2) *Effect of the solar noise storm on August 22.* Another period when substantial increases were observed in the zone began on August 22 and covered a period of five to six days thereafter. Coincident with the beginning of these increases in the outer zone there was a striking solar disturbance. It reached very high intensity on the days that followed and high levels of radio emission from the Sun attributed to synchrotron radiation from electrons at a great distance from the disc, were observed by a number of solar stations.

British *Scout I* Experiments

The University College technique of probing the ionosphere from a satellite, which is being incorporated in the *Scout I* instrument package, derives from experiments on ionised gases developed in the laboratory over several years by a group led by Drs R. L. F. Boyd and A. P. Willmore. This in turn is a development of I. Langmuir's work on gas discharges in the 1920s. The core of the experiment is the sensitive measurement possible from electronic analysis of Langmuir-probe sweep data on electron temperature of the ambient gas through which a space-vehicle passes. The probe technique relies on the relationship between the voltage on an electrode (the probe) and the current flowing to it. For instance, if the applied voltage is positive it will collect free electrons and negative ions; if negative, positive ions will be attracted. Furthermore, if the voltage is only slightly negative some of the negative particles will still be able to reach it because they have sufficient energy to overcome the repulsion of the probe charge and thus the energy of the particles can be obtained.

Electronic analysis enables these complicated variations to be sorted into: (1) electron temperature values from which electron densities can be calculated; and (2) the energy spectrum of the impinging ions. The method of analysis evolved by the University College group is particularly suited to satellite studies. This will be the first time it has been used for space research.

Very little is known about the nature of the ions in the F-layer of the ionosphere (above 130 km.) and there are no data on changes with latitude, time of day and time of year. The comparatively long lifetime and wide latitude range of a satellite makes it an obvious tool for such studies. Moreover, the hypersonic velocity at which it travels enables the energy spectrum to be directly converted into a mass spectrum. The way this works is as follows. The speed of the satellite is much greater than the mean random speed of the electrons. Therefore the energy of an impacting ion is approximately half the mass of the ion, times the satellite velocity squared.

One probe in the satellite version will be mounted flush with the satellite casing; the other, a sphere, will be mounted at the axis of spin of the spherical vehicle. In this way the probe is insensitive to the orientation and attitude of the satellite.

In conjunction with the series of measurements to be made by the Langmuir probe directly on the charged par-

ticle population of the ionosphere, two ranges of solar radiation that do not penetrate the atmosphere will be monitored from the satellite. Sensors sensitive in the spectrum range 8 Å to 20 Å will keep track of the x-ray fluxes produced in the corona by solar disturbances, which in turn can be correlated with the ion measurements. A second range of measurements will be made of the solar ultra-violet rays at the Lyman α wavelength of 1216 Å. It is known that the ionosphere is largely governed by these short-wave solar radiations which, in contrast to the visible light that penetrates to the Earth's surface, are very variable in intensity. A satellite carrying both sets of instruments should give a detailed plot of the effect on the ionosphere of changes in the Sun.

New "Deep" in the Indian Ocean

The Australian naval frigate *Diamantina*, on her first cruise newly equipped as an oceanographical survey vessel, discovered in February a previously unknown ocean deep in the Indian Ocean, plunging down to as much as five miles. Now called the Diamantina Deep, the trench is located 620 miles west of the south-west corner of Australia, off Cape Leeuwin. The *Diamantina* detected the trench when her echo-sounder measured an increase in bottom depth running from 2500 fathoms to 3400 fathoms in two minutes steaming, and then a sudden plunge to 4400 fathoms (about five miles). The deepest previously known deep in the Indian Ocean is the Sunda Trench off Java where the depth is 3838 fathoms.

Later in February the American oceanographical vessel *Vema* traced the Diamantina Trench for three hundred miles.

At the present time the Indian Ocean is the least explored of the world's oceans. To fill in this gap in knowledge of the world's oceans two international bodies, SCOR and UNESCO, are now concerning themselves with investigating the area. At its meeting in New York last autumn, SCOR (Special Committee for Oceanographical Research) drew up plans for a massive multi-nation expedition to the Indian Ocean to be principally concentrated in the year's 1962–3. So far eleven nations have indicated their intention to take part. Besides several of the countries whose coasts border the Ocean, the U.S., U.S.S.R., and Britain plan to send oceanographical ships to take part in the expedition. Cost is at present being estimated at $12,500,000.

Sodom Destroyed by Nuclear Explosion?

The Soviet mathematician M. Agrest recently put forward in an article in *Literaturnaya Gazeta* the amusing hypothesis that the Earth may have been visited by space-travellers from another part of the universe some million years ago. He gives four pieces of evidence that may be taken to support the idea. He appeals to historians and archaeologists to examine again for further evidence ancient enigmas that have puzzled scholars.

The plentiful crop of tektites, minute scraps of glassy extra-terrestrial material which sometimes show traces of aluminium and beryllium, in the Libyan Desert and elsewhere could have been the remains of space probes falling on the Earth's surface. The vast and unexplained Baalbek terrace, a platform of huge stone slabs located not far from the Libyan Desert, might, Agrest suggests, be the remains of a rocket-launching platform or of a structure commemorating the space-travellers' visit to Earth. The Account in the recently recovered Dead Sea Scrolls of the destruction of Sodom and Gomorrah seems consistent with the deliberate exploding of a nuclear stockpile. The people of these cities were warned to leave the area when an explosion was to take place, not to linger in the open and not to look. Those who looked back lost their eyesight and perished.

The story that Agrest threads together from these admittedly puzzling scraps runs as follows. A huge space-ship approached the Earth carrying people of highly developed technical skill from another part of the universe. While relatively close to the Earth, probes were launched towards the Earth to see if it was a suitable place to land—hence the tektites. The space party landed and spent an unspecified time here. Eventually, however, they departed as they came, by rocket. Before they left, which may have been through the use of a launcher at Baalbek, the visitors wished to destroy some surplus nuclear rocket fuel that they had accumulated. During the course of this Sodom and Gomorrah were also destroyed and their destruction passed into legend. Other unexpectedly advanced astronomical concepts which are sometimes found embedded in ancient legends and cultures may also have derived from the space-travellers visit. They would have tried to pass on their knowledge.

SPACE CALENDAR

FEBRUARY

2 First fully successful *Titan* test launch in nine months.

4 Announcement that radio echoes were successfully bounced off the solar corona on April 7, 10, and 12 last year by Stanford University scientists. Total distance travelled: 186 million miles; power: 40,000 watts; frequency: 25·6 Mc/s. It has taken since last April for computers to confirm contact was made.

4 *Titan* veered off course and destroyed.

4 *Discoverer IX* satellite launched successfully, but recovery failed.

11 It was announced that U.S. anti-aircraft missile successfully intercepted and destroyed *Honest John* short-range missile in flight for the first time.

10 Announcement that since December 19 the U.S. Navy has been observing an unidentified earth satellite in a polar orbit, about the size of a *Discoverer* carrier rocket, and with a period of 104 minutes. It is officially described as "space garbage"—either the remnants of a *Discoverer* or the penultimate stage of *Lunik III*.

15 Publication of Defence White Paper casts doubts on the British *Blue Streak* IRBM programme.

16 NASA likely to buy British *Skylark* solid-fuel research rockets for work at Woomera. Discussions with the Australians for extending the ultra-violet rocket astronomy survey to the southern hemisphere has been going on for a year.

20 *Discoverer X* failed and had to be destroyed on launch.

20 Announcement that Radio Research, Slough, is to operate a Minitrack satellite tracking installation as part of the primary tracking network for *Scout* and other earth satellites. It will be equipped to monitor the new tracking frequency at 136 Mc/s.

26 *Midas*, short for "Military Defence Alarm System", the U.S. Defence Department's reconnaissance satellite for monitoring the approach of enemy missiles, failed to go into orbit on its first trial from Cape Canaveral. The satellite weighs two tons and is launched by an *Atlas-Agena* combination. Its orbit was intended to avoid the U.S.S.R.

26 Australia is to have stations at Perth and Woomera for monitoring the U.S. *Project Mercury*.

28 Some details of the U.S. *Skybolt* 1000-mile-range aircraft-launched missile was released by the prime contractors, Douglas Aircraft. $60 million is to be spent on *Skybolt* during fiscal year 1960.

28 Third test of *Echo* passive communications system successful. A voice transmission satisfactorily bounced off 130-ft. diameter balloon launched by rocket from Wallops Island.

SCIENCE ON THE SCREEN

Photography at Work

16 mm., sound, colour, running time, 22 minutes. Produced by Technical and Scientific Films Ltd in conjunction with Film Producers Guild for Kodak Ltd. (*This film is on loan free of charge from Sound Services Ltd, Wilton Crescent, Merton Park, S.W.19.*)

Your reviewer is not going to write about the film on its own, but about the total presentation when he saw it at Kodak's headquarters in London. It was introduced by an extremely clever and well conceived talk, which pre-disposed the audience to look at the film with sympathy. It is impossible to say if sympathy was necessary, because the introduction made one so receptive that it could only be seen as a whole presentation.

After describing how Kodak has used booklets and advertising to put over the use of photography as a tool for science and industry, the speaker said: "This is naturally done by us as a service to industry. Naturally we have another reason, but I can't quite remember what it is." Then the lights went out as if the film was going to start. The lights came on and the speaker continued: "Yes, naturally we are trying to sell the stuff." This blackout produced a warm laugh and his method of presentation, much more human than the printed word can ever show, completely won the audience.

The film, like so many others of its genre, is a catalogue. It is difficult to see how it could be anything else. It sets out, as did the British Electrical Development Association's "Industrial Electric Heating" (see DISCOVERY, 1959, vol. 20, No. 12, p. 544), to show ways in which in one case, photography, and in the other electric heating, could be used in modern industry. Both these films were made by the Film Producers Guild, and both show signs of coming from the same stable.

The colour photography is, as it would have to be, impeccable. The many uses of film are shown briefly at the beginning. We see the permanent record of flight, on new processes and a shooting star. Almost everything can be fixed for future examination by one or another photographic method. There is an almost revolting sequence showing how a razor blade cuts the stubble on a human face. High-speed cinematography slows down and analyses movement. Time lapse makes an apple rot and decay in seconds instead of days. Cinemicrography shows a whole range of potential uses to the industrialist and the scientist.

Radiography has many uses. X-ray inspection is absolutely essential in the testing of welds, in the construction of an atom plant, and in the building of aircraft.

After a quick run through the gamut, the film then slows down to show some examples in more detail. We see its use in Motion Study. They took an interesting example. A large store was being examined, and the fishmonger was losing custom, though a first-class man. On studying the film it was seen that he went through a door to fillet fish. Customers thought the counter was unattended, so they did not wait. This study of human conduct revealed the simple solution of allowing him to fillet and prepare fish in full view. This proved sufficient to satisfy the waiting customers. What had been happening had not been noticed until the photographic study was made.

Besides a number of other technical and scientific uses we see Air Survey, in relation to the design of the new M1 road. The value of microfilm as a means of filing, and photocopying is shown.

There is then a section on the use of photography in teaching, including photographs used for teaching, teaching films, and sound filmstrips. This is one of the less happy sequences of the film and it highlights the weaknesses of this type of omnibus film. The examples taken are not very convincing, and the treatment of the use of visual aids is very superficial.

Frankly this film is little more than a good catalogue—as such it is interesting. To people who do not know that photographic techniques are capable of more than filling family albums, it will be of great interest. It does not need dramatic or story interest, but what would improve it greatly would be a deeper penetration into the problems. If each vignette had been more carefully and analytically considered as a case history, the result would have been more intellectually satisfying. The one or two cases where this is done, as in the case of the fishmonger and Motion Study, and another case in which an X-ray photograph was used to diagnose failure in a refrigerator motor, the film would have been more satisfactory.

One never felt in the film that scientists and experts were trying to solve problems. Nevertheless your reviewer left the theatre quite convinced that Industry could not exist without photography, and also convinced by the photographic quality and clear colours that film can be a beautiful and exact means of reproduction. Yes, the film achieved its aim, but it could have achieved it more perfectly if the approach had been a little more profound.

L. GOULD-MARKS

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